

# A CASE OF ANAPHYLACTIC REACTION FOLLOWING OYSTER MUSHROOM (*PLEUROTUS OSTREATUS*) INHALATION

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## Abstract

Oyster mushroom (*Pleurotus ostreatus*) is one of the most widely consumed mushrooms in the world. Its spores are highly potent allergens, but their main allergen, *Pleo*, has so far been very rarely reported. In indoor farms, fungal spores are often found to be floating in the air. This study presents a case of a non-atopic, healthy 32-year-old woman who opened an oyster mushroom farm with her husband. During the first harvest, after 30-minute exposure, she experienced dyspnoea. Similar symptoms occurred several more times while on the farm. A month later, during packing and sorting mushrooms, after 10 min, she again felt dyspnea, accompanied by weakness, rapid pulse, and skin itching with urticaria which occurred on her forearms. Immediately after one of the exposures to oyster mushrooms, spirometry was performed. The results showed a reduced airflow obstruction. Standard skin prick tests with an inhalant and food allergens were also performed – all rendering negative results. The diagnosis also included a prick-to-prick test with oyster mushrooms (a wheal size of 12 mm), this time with a positive result. Increased total IgE (78 iu/ml) in the serum was recorded. On the basis of her medical history, reported symptoms and diagnostic tests, the patient could be diagnosed with occupational anaphylaxis and work-related asthma. A constant exposure of indoor mushroom cultivators to *Pleurotus ostreatus* spores increases the risk of respiratory allergy development. An environmental monitoring of oyster mushroom spores is reasonable in the industry, as it may prove useful in the prevention of the disease. Int J Occup Med Environ Health. 2021;34(4):575–9

## Key words:

allergic asthma, anaphylaxis, oyster mushroom, *Pleurotus ostreatus*, mushroom allergy, occupational allergy

## INTRODUCTION

Oyster mushroom (*Pleurotus ostreatus*) belongs to the *Fungi* kingdom, the *Basidiomycota* division, the *Basidiomycetes* class, the *Tricholomataceae* family, and the *Pleurotus* genus. The number of all mushroom types is estimated at about 1.5 million species of which only about 3–8% are known [1]. Among the fungi, the most known allergens are molds. There have been isolated reports of the allergenic effect of oyster mushrooms. Allergy to oyster mushrooms can be caused by an IgE-dependent mechanism (type I hypersensitivity) or an IgE-independent mechanism (type III hypersensitivity

reaction involving immune complexes). Non-immunological hypersensitivity reactions associated with fungal trehalose are less common. Allergic reactions to oyster mushrooms are rarely reported.

Oyster mushrooms are one of the most widely consumed mushrooms in the world. They are not only frequently used in Japanese, Korean or Chinese cuisines, but they also quickly gain popularity in other countries, being considered a delicacy. In many European countries, there are grounded farms where these mushrooms are industrially produced, not only for culinary purposes. The oyster

Received: February 17, 2020. Accepted: December 9, 2020.

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**Figure 1.** A morphological structure of a cultivated oyster mushroom

mushroom development cycle lasts a whole year. It has a broad, fan or oyster-shaped cap and gills (Figure 1). Individual species may differ in appearance, shape and color. Hence, it is easy to confuse it with other types of mushrooms. In natural settings, they mostly grow on tree trunks and branches, mainly on willows and pines [2]. In cultivation conditions, they grow on high-humidity substrates, organic composts or straw. In mushroom farms, fungal spores are often found to be floating in the air. Therefore, oyster mushroom cultivators are more likely to develop clinical signs of respiratory allergy. Cases of harmful effects in sensitive persons consuming mushrooms are also described. To the best of the authors' knowledge, this study presents the first case of asthma due to oyster mushrooms in Poland.

Oyster mushroom spores are highly potent allergens, but their main allergen, *Pleo*, has been so far very sparsely characterized. The diagnosis of oyster mushroom allergy is based on a medical history and prick-to-prick tests. Standardized allergen extracts to perform prick tests, or to determine the specific IgE level in blood, are commercially unavailable. This may be caused by the low incidence of this form of allergic reaction, as reflected in the limited body of literature available.

### CASE REPORT

This study presents a case of a non-atopic, healthy 32-year-old woman who opened an oyster mushroom farm with her husband. During the first harvest, after 30-minute exposure, she experienced shortness of breath that made her leave the farm building immediately. Three days later, she entered the farm once more and felt dyspnea accompanied by weakness, rapid pulse hives and skin itching. During 5 cautious attempts, she always felt dyspnea after spending about 15 min at the farm.

Immediately after one of the exposures to oyster mushrooms, the patient reported to the allergology clinic where spirometry was performed. The results showed a reduced airflow obstruction, with the following outcomes: FEV<sub>1</sub> 2.13 (57% ref.), FVC 4.2 (92% ref.) FEV<sub>1%</sub> 50.71%, and PEF 2.52 (28% ref.). The post-bronchodilator test result was positive, and FEV<sub>1</sub> increased to 2.65l (0.45l, 21%). After a while, control spirometry was performed in a stable condition (without allergen exposure), rendering the following results: FEV<sub>1</sub> 3.42 (91% ref.), FVC 4.34 (95% ref.), FEV<sub>1</sub> %VC 78.84%, and PEF 8.45 (93% ref.).

A month later, the patient re-entered the farm and during packing and sorting mushrooms, after 10 min, she felt dyspnea accompanied by weakness, rapid pulse and skin itching with urticaria on her forearms. There were no co-factors, such as infection, alcohol consumption or physical exertion. The patient called an ambulance and received medication (no documentation). Skin prick tests (SPTs)

with an inhalant and food allergens were performed, with allergen extracts including house dust mites (*Dermatophagoides pteronyssinus* and *Dermatophagoides farinae*), timothy grass, ryegrass, rye, alder, hazel, birch, plantain, mugwort, nettle, dog's and cat's dander, milk, soy, wheat, eggs, tree nuts, fish, shellfish, peanuts, 0.1% histamine, and a control solution (Allergopharma, Reinbek, Germany) – all rendering negative results. The diagnosis also included a prick-to-prick test with oyster mushrooms (a wheal size of 12 mm) – this time with a positive result. The total IgE level in the serum was 72 iu/ml. The patient refused another provocative (inhalation) test and performed a specific inhalation challenge which, according to the criteria, confirmed the diagnosis of occupational asthma.

On the basis of the patient's history, the immediate positive skin reactions in the prick-to-prick tests and the demonstration of bronchial constriction after repeated exposure to oyster mushrooms in the workplace challenge test, the diagnosis of occupational anaphylaxis, based on the European Academy of Allergy and Clinical Immunology [3], and asthma due to workplace allergens, was confirmed.

The patient was treated with antihistamines (cetirizine 10 mg) and short-acting  $\beta$ -agonist inhalations during exacerbations. The treatment was changed to a combination of budesonide and formoterol, at 160  $\mu\text{g}$  + 4.5  $\mu\text{g}$  2 $\times$ 1 inhalation, resulting in significant improvement. Finally, the patient decided to quit her job and to resign from any activities in the vicinity of the farm.

## DISCUSSION

The growing use of oyster mushrooms as edible fungi and their increased popularity in Western Europe results in unfavorable symptoms of non-immunological hypersensitivity. Gastrointestinal symptoms such as stomach ache sometimes occur a few hours after ingesting oyster mushrooms. This reaction is caused by the lack of the enzyme decomposing trehalose, which typically occurs in fungi.

It can be classified as an adverse enzymatic non-immunological digestive reaction. Literature contains several reports regarding allergic reactions caused by oyster mushrooms. Studies by German and Swiss authors have shown a large allergenic potential of oyster mushroom spores [4,5]. Horner et al. [4] have identified and characterized *Pleurotus ostreatus* spore allergens. The oyster mushroom protein size ranges 10.5–25 kD.

Lehrer et al. [6] described the incidence of basidiomycete allergy in the USA and Europe. In total, 178 out of 701 participants (25.4%) reacted to at least 1 basidiomycete. Among 8 species, *Pleurotus ostreatus* was the second most allergenic species tested [6]. Another experimental study evaluated the allergenic effect of the 3 most common basidiomycete types (including oyster mushroom) on the respiratory system. More than 1000 people underwent SPTs with inhalant allergens and with 3 types of tested fungi. The effect of the study was evaluated by the results of anterior rhinomanometry and the IgE level in the serum. The study confirmed a more frequent allergy to basidiomycete in sensitive individuals [7]. Another study demonstrated the ability to initiate an IgE-dependent allergy reaction in patients during the nasal challenge with a *Pleurotus* spore extract. The patients presented symptoms of rhinitis, conjunctivitis and asthma. The results showed airflow obstruction with decreased FEV<sub>1</sub> and the presence of specific IgE in the serum [8].

Occupational asthma is often associated with exposure to mushroom spores. For the first time in literature, an occupational asthma description appeared in 1938 [9]. In subsequent publications dated 1999 [10], fungus-induced allergy was also confirmed, with specific biological characteristics of mushrooms types. A study carried out in Spain in 2005 documented the allergenic role of further species of fungi, including *Pleurotus*, in triggering bronchial asthma attacks and allergic rhinitis. The study used the sodium dodecyl sulphate–polyacrylamide gel

electrophoresis method to assess the presence of allergenic proteins in the cultivators' blood serum. The results of the study obtained proved the inducing of symptoms of occupational asthma [11]. Mori et al. [12] also reported the occurrence of allergic alveolitis in 2 indoor cultivators of oyster mushroom.

The first report of allergic asthma caused by *Pleurotus ostreatus* was published by Swiss authors in 2001. The case described a farmer who was working on an oyster mushroom farm and developed symptoms of bronchial asthma during work. The symptoms disappeared after leaving the workplace. Allergy diagnostics confirmed the presence of specific IgE in the patient's serum and the coexistence of allergy to other aeroallergens [13]. Unfortunately, the patient did not undergo a specific inhalation challenge which mostly confirms the diagnosis of occupational asthma.

The majority of the basidiomycete sensitive subjects are allergic patients with clinical symptoms to other allergens and skin test reactivity to common inhalant allergens [6]. In this case, the patient was selectively allergic to oyster mushroom. The storage condition can change the characteristics, the commercial value, and the biological efficiency of mushrooms. A higher concentration of spores is observed in fresh, young mushrooms. This was consistent with symptoms reported by this patient after contact with fresh mushrooms.

A small number of reports confirm the allergenic potential of oyster mushroom spores and their part in triggering IgE-dependent allergies. It is worth mentioning that Tepetam et al. [14] described a case report of a 39-year-old woman with Kounis syndrome (acute coronary syndrome associated with anaphylactic reaction) due to oyster mushrooms. Also, the ability of *Pleurotus* mushrooms to trigger immune hypersensitivity type III reaction in the Gell-Coombs classification was confirmed. Clinically, it manifests as extrinsic allergic alveolitis, currently known as hypersensitivity pneumonitis. After prolonged and constant exposure to the allergen, patients develop symptoms such as cough, shortness of breath, muscle and joint pain, chills,

fever, weakness and headache. The severity of these conditions depends on the duration and frequency of exposure. Physical examinations reveal crackling at the base of the lung and shortness of breath, accompanied by serum leukocytosis, decreased spirometry parameters, and an immunological presence of specific IgG in the serum [15].

Oyster mushrooms belong to the oriental mushrooms group similarly to shiitake; they may occasionally cause allergic contact dermatitis or other allergic dermatitis. More common allergic reactions caused by oyster mushrooms include allergic rhinitis, conjunctivitis, cough and attacks of allergic asthma, as well as occupational asthma. No cases of anaphylaxis shock after oyster mushrooms have been described. The use of appropriate personal protective equipment is recommended as an element of primary prevention, but other methods of decreasing the concentration of occupational agents should also be implemented. In the described case report, on the basis of the patient's medical history and the diagnostic tests performed, anaphylactic reactions could be diagnosed. Unfortunately, due to incomplete diagnostics, the authors were unable to diagnose allergic and work-related asthma. The presented cases indicate the need for monitoring the environmental spore level in oyster mushroom farms in order to reduce the risk of sensitization and the development of respiratory diseases.

## REFERENCES

1. Hawksworth D, Lücking R. Fungal Diversity Revisited: 2.2 to 3.8 Million Species, In: Heitman J, Howlett B, Crous P, Stukenbrock E, James T, Gow N, editors. The Fungal Kingdom [Internet]. Washington, DC: ASM Press; 2016 [cited Feb 10, 2020]. p. 79–95. Available from: <https://doi.org/10.1128/9781555819583.ch4>.
2. Raman J, Jang K-Y, Oh Y-L, Oh M, Im J-H, Lakshmanan H, et al. Cultivation and Nutritional Value of Prominent *Pleurotus* Spp.: An Overview. *Mycobiology*. 2021;49(1):1–14, <https://doi.org/10.1080/12298093.2020.1835142>.

3. Siracusa A, Folletti I, Gerth van Wijk R, Jeebhay MF, Moscato G, Quirce S, et al. Occupational anaphylaxis – an EAACI task force consensus statement. *Allergy*. 2015;70(2):141–52, <https://doi.org/10.1111/all.12541>.
4. Horner WE, Ibanez MD, Liengswangwong V, Salvaggio JE, Lehrer SB. Characterization of allergens from spores of the oyster mushroom, *Pleurotus*. *J Allergy Clin Immunol*. 1998;82:978–86, [https://doi.org/10.1016/0091-6749\(88\)90134-0](https://doi.org/10.1016/0091-6749(88)90134-0).
5. Betz B. Respiratory tract diseases in oyster mushroom cultivators. *Pneumonologie*. 1990;44:339–40.
6. Lehrer SB, Hughes JM, Altman LC, Bousquet J, Davies RJ, Gell L, et al. Prevalence of basidiomycete allergy in the USA and Europe and its relationship to allergic respiratory symptoms. *Allergy*. 1994;49:460–5, <https://doi.org/10.1111/j.1398-9995.1994.tb00840.x>.
7. Helbling A, Gayer F, Pichler WJ, Brander KA. Mushroom (Basidiomycete) allergy: diagnosis established by skin test and nasal challenge. *J Allergy Clin Immunol*. 1998;102:853–8, [https://doi.org/10.1016/s0091-6749\(98\)70028-4](https://doi.org/10.1016/s0091-6749(98)70028-4).
8. Helbing A, Gayer F, Brander KA. Respiratory allergy to mushroom spores: not well recognized, but relevant. *Ann Allergy Asthma Immunol*. 1999;83:17–9, [https://doi.org/10.1016/S1081-1206\(10\)63506-5](https://doi.org/10.1016/S1081-1206(10)63506-5).
9. Kern RA. Asthma due to sensitization to mushroom fly (*Aphiocatea*). *J Allergy*. 1938;9:604–6.
10. Cimarra M, Martinez-Cóccera C, Chamorro M, Cabrera M, Robredo T, Lombardero M, et al. Occupational asthma caused by champignon flies. *Allergy*. 1999;54:521–5, <https://doi.org/10.1034/j.1398-9995.1999.00015.x>.
11. Senti G, Leser C, Lundberg M, Wuthrich B. Allergic asthma to shiitake and oyster mushroom. *Allergy*. 2001;55:975–6, <https://doi.org/10.1034/j.1398-9995.2000.00557.x>.
12. Mori S, Nakagawa-Yoshida K, Tsuchihashi H, Koreeda Y, Kawabata M, Nishiura Y, et al. Mushroom worker's lung resulting from indoor cultivation of *Pleurotus ostreatus*. *Occup Med (Lond)*. 1998;48(7):465–8, <https://doi.org/10.1093/occmed/48.7.465>.
13. Venturini M, Lobera T, Blasco A, Del Pozo MD, González I, Bartolome B. Occupational asthma caused by white mushroom. *J Invest Allergol Clin Immunol*. 2005;15:219–21.
14. Tepetam FM, Dağdeviren B, Bulut İ, Karabay CY, Barış S, Aydın Karakoç E. A patient with mushroom allergy; a new etiological agent of Kounis syndrome. *Tuberk Toraks*. 2016;64(2):171–4, <https://doi.org/10.5578/tt.9411>.
15. Cox A, Folgering HT, van Griensven LJ. Extrinsic allergic alveolitis caused by spores of the oyster mushroom *pleurotus ostreatus*. *Eur Respir J*. 1988;1:466–8.