**PROCEEDINGS OF THE YEREVAN STATE UNIVERSITY**

*Chemistry and Biology* 2022, **56**(2), p. 169–174

*Biology*

# INFLUENCE OF *PELARGONIUM GRAVEOLENS* L'HER. ON THE INDOOR AIR MYCOBIOTA

A. V. POGHOSYAN [*], I. M. ELOYAN [**], R. G. ADAMYAN [***], A. M. PETROSYAN [****], L. V. MARGARYAN [*****], S. G. NANAGULYAN [******]

*Chair of Botany and Mycology, YSU, Armenia*

One of the most important problems is to reduce the level of indoor air contamination by micromycete. It is known that houseplants with high phytoncide activity have an antifungal effect. In order to reduce the level of contamination in the air of the office room, *Pelargonium graveolens* L'Her. plant and essential oil of Geranium were used. The results of the study showed that the level of air pollution with micromycetes was reduced 3 times when there was a *Pelargonium graveolens* plant in the room, and the air contamination is reduced 4 times when there is houseplant combined with Geranium essential oil.

https://doi.org/10.46991/PYSU:B/2022.56.2.169

***Keywords*:** houseplant, *Pelargonium graveolens*, Geranium essential oil, micromycetes, antifungal activity.

**Introduction.** The study of the mycobiota of air environment in enclosed multifunctional spaces has become increasingly important within the recent decades. It is the most important component of comprehensive research aimed at solving a number of issues related to the need to ensure the quality of life of people in the complicated environmental conditions of the modern urban formation.

The composition of micromycetes of the air environment is formed under the influence of ecological and geographical conditions, microclimate and a number of anthropogenic factors. The latter, as a rule, largely contribute to the accumulation and development of fungi indoors. The most important role in the indicated processes belongs to the indicators of temperature and humidity, which also determine the general hydrothermal regimen, contributing to the growth of fungi [1].

A number of authors, conducting multi-year mycological studies of the air of various premises in different countries, revealed the same dominant group of fungi, the representatives of the genera *Cladosporium*, *Aspergillus*, *Penicillium*, *Alternaria*, etc. However, given the different climatic conditions of the external environment and the type of premises, the groups of dominant fungi may respectively differ. Thus, in warm countries species of the genera *Cladosporium* and *Aspergillus* predominate, and as for Europe, *Penicillium* and *Cladosporium*, then *Aspergillus* and *Alternaria* prevalent [2].

[*] E-mail: astchik@ysu.am
[**] E-mail: eloyaninessa@ysu.am
[***] E-mail: radamyan@ysu.am
[****] E-mail: aida.petrosyan@ysu.am
[*****] E-mail: lusinemargaryan@ysu.am
[******] E-mail: snanagulyan@ysu.am

The main reservoir of microscopic fungi-micromycetes in nature is the soil, from where fungal spores fall on various objects around us, including the air. There are available literature reports on the content of spores in various layers of indoor area. The maximum content of spores is detected at a height of 0.25 *m* from the floor surface, where species of the genus *Cladosporium* are prevalent, which have large and heavy melanized spores. Comparatively fewer spores were found at a height of 1.25 *m*, where species of the genus *Penicillium* are prevalent. The maximum number of spores is observed under the ceiling at a height of 2–2.5 *m*, where thermophilic species of the genus *Aspergillus* are prevalent in a relatively warm air layer [3].

Taking into account the results of multilateral studies on the assessment of the environmental consequences caused by the development of fungi, the need for the development and implementation of standards for checking air pollution in rooms for various purposes in accordance with the specifics of the latter becomes more and more urgent. Of particular interest are works on assessing the qualitative and quantitative composition of micromycetes in the air mycobiota, identifying their structural complexes and developing methods for protecting the air environment of premises for various purposes from mycological pollution.

The spread of opportunistic fungi in the human environment is assessed by their presence in the "internal environment", that is, indoors, and it is in multifunctional premises that people spend most of their time. The most important indicator of the mycological state of the human environment is the number of microscopic fungi in the environment. This indicator is assessed by the representation (the number of colony-forming units, CFU) and the composition of fungi in the air [4–6].

As a result of a number of studies, a large number of indoor plants have been isolated with antibacterial, antiviral and antifungal activity. These plants can be grown in various indoor spaces for prophylactic and medicinal purposes. These species "include fragrant" geranium [7].

In order to improve the ecological and hygienic quality of air in multifunctional premises and ensure hygienic safety, it is necessary to use tropical and subtropical plants. In recent years, there has been a need for the study and application of these plants in indoor conditions. According to the literature records, essential oil plants contribute to the purification of the air mycobiota from conditionally pathogenic species of micromycetes [8, 9].

Taking into consideration all mentioned above information, we carried out mycological studies of the air mycobiota of the office room of the Faculty of Biology of YSU in the presence of a houseplant *Pelargonium graveolens* and essential oil – Geranium essential oil, in order to study both the species composition of micromycetes and to determine the degree of infestation of mycobiota without a houseplant.

**Material and Methods.** The material for the study was the houseplant *Pelargonium graveolens* L'Her., as well as the pharmacy Geranium essential oil ("Aromatika"). The species of geranium used for study purposes was grown in the greenhouse of YSU by cuttings. The geranium was grown on leached soil taken from different agricultural areas in Armenia.

Studies of the air mycobiota were carried out with a PU-1B sampling apparatus, which states the number of colony-forming units (CFU) in 1 $m^3$ of air.

The level of air inhaled by a person is taken into account at a height of 1.5–1.8 *m* from the floor [10].

The setting up of experiments, as well as the detection and identification of microscopic soil fungi were carried out in the research laboratory of experimental mycology at the Department of Botany and Mycology, Faculty of Biology, YSU.

Mycological analysis of air was carried out using a nutrient medium (wort-agar), the propagules of micromycetes were incubated at a temperature of 26–28°C until the appearance of the germs of colonies. The identification of micromycetes was carried out using a number of identifiers, taking into account the morphological and cultural characteristics of the species [11–14].

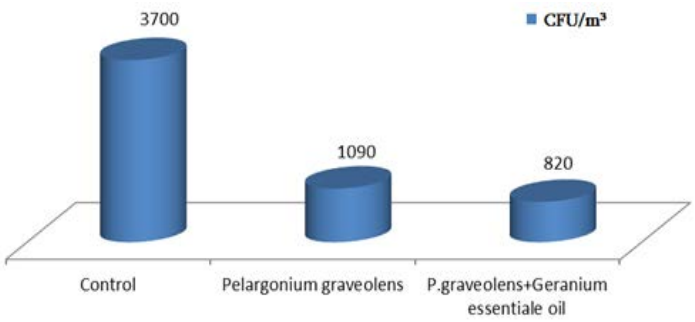
Mycological analysis of soil samples was carried out according to the generally accepted method of serial dilutions of soil suspension using a wort-agar nutrient medium with some changes according to [15].

**Results and Discussion.** The plants assortment used for indoor landscaping is associated with the optimization of the environment, since plants are considered as universal filter. In the general system of environmental optimization, phytodesign is aimed not only at aesthetic education, mental stress release, but also at improvement of the sanitary and hygienic conditions of places of work and rest [16].

Taking into account the high antifungal activity of essential oil indoor plants and their use for the sanitation of premises, as well as phytodesign, the plant *Pelargonium graveolens* was selected.

Fragrant geranium (*Pelargonium graveolens*) belongs to the Geraniaceae family. It is a perennial flowering plant with bright green palmate and pubescent leafy arrangement. The plant has a well-developed root system and light pink flowers, collected in umbellate inflorescences. Fragrant geranium is easily propagated by cuttings. Homeland of the plant is South Africa. Geranium fills the air with phytoncides and essential substances that act as a sedative on the human body. The main component of geranium is gerinol, which is able to suppress the pathogenic mycoflora of the air, thanks to its antibacterial and antimicrobial properties. The essential oil of this plant is widely used in medicine [17].

Carrying out mycological studies of the mycobiota of the office room air with absent indoor plants (control), the representative following genera of fungi were revealed: *Penicillium*, *Aspergillus*, *Cladosporium*, *Trichoderma* and *Rhizoctonia*, as a result of which the air congestion significantly exceeded the permissible norm and amounted to 3700 CFU/$m^3$ (see Figure).




Air congestion in the room of the YSU in CFU/$m^3$.

The species diversity of mycobiota is as follows: *Aspergillus niger* = 30 CFU/$m^3$, *A. ochraceus* = 10 CFU/$m^3$, *Penicillium lanosum* = 300 CFU/$m^3$, *Rhizoctonia solani* = 30 CFU/$m^3$, *Trichoderma koningii* = 2800 CFU/$m^3$, *Cladosporium herbarum* = 500 CFU/$m^3$.

Further studies of the air mycobiota were carried out in the presence of a houseplant *Pelargonium graveolens*, which was kept in the office for a month. As a result of mycological analysis, the species of *Penicillium lanosum* = 200 CFU/$m^3$, *Cladosporium herbarum* = 300 CFU/$m^3$, *Trichoderma koningii* = 590 CFU/$m^3$ were found, where the total air pollution is 1090 CFU/$m^3$, which exceeds the permissible norm, but below the previous data.

The next stage of research in the presence of the plant *P. graveolens* was the use of the essential oil – Geranium essential oil. The oil was sprayed into the air every day for a month. As a result of mycological analysis of mycobiota, the air pollution was 820 CFU/$m^3$, which also exceeds the permissible norm, but less than the previous data. The species composition of microscopic fungi is as follows: *Trichoderma koningii* = 500 CFU/$m^3$, *Penicillium lanosum* = 280 CFU/$m^3$, *Cladosporium herbarum* = 40 CFU/$m^3$.

Based on the obtained data, air pollution with fungal spores in the presence of the houseplant *P. graveolens*, as well as *P. graveolens* in combination with the Geranium essential oil decreased by 3 and 4 times, respectively.

The mycological analysis of the soil, along with the above-mentioned species of fungi, the following micromycetes were identified – *Aspergillus flavus*, *A. terreus*, *Penicillium canescens*, *P. cyclopium*, *Trichoderma viride*.

As a result of mycological studies of the office room air mycobiota, 6 species of microscopic fungi belonging to 5 genera were identified. The genus Aspergillus is represented by two species, and the genera *Penicillium*, *Trichoderma*, *Rhizoctonia*, and *Cladosporium* are represented by one species (see Table).

Mycological studies of the room air and soil identified 11 species of microscopic fungi belongs to 5 genera. The genus *Aspergillus* is represented by 4 species, the genus *Penicillium* – 3 species, *Trichoderma* – 2 species and the genera *Rhizoctonia* and *Cladosporium* by one species (see Table).

*Taxonomic composition of identified fungal species from air and soil*

| No | Division | Class | Order | Family | Genus | Species |
|---|---|---|---|---|---|---|
| 1 | Ascomycota | Eurotiomycetes | Eurotiales | Aspergillaceae | Aspergillus | *A. niger* |
| 2 | | | | | | *A. ochraceus* |
| 3 | | | | | | *A. flavus* |
| 4 | | | | | | *A. terreus* |
| 5 | | | | | Penicillium | *P. lanosum* |
| 6 | | | | | | *P. canescens* |
| 7 | | | | | | *P. cyclopium* |
| 8 | | Dothideomycetes | Cladosporiales | Cladosporiaceae | Cladosporium | *C. herbarum* |
| 9 | | Sordariomycetes | Hypocreales | Hypocreaceae | Trichoderma | *T. koningii* |
| 10 | | | | | | *T. viride* |
| 11 | Basidiomycota | Agaricomycetes | Cantharellales | Ceratobasidiaceae | Rhizoctonia | *R. solani* |

Over the past decades, mycological studies of mycobiota on indoor air pollution and the fight against microscopic fungi are of concern to many mycologists. Reducing the level of indoor air congestion by biological methods, using indoor plants, as well as their essential oils, is becoming the most relevant and acceptable. This is the first time such studies have been carried out in Armenia.

Based on a number of studies, we propose to use the *Pelargonium graveolens* plant both as gardening in closed rooms and in order to reduce air pollution.

*This work was supported by the Science Committee of the MESCS RA, in the frames of the research project No. 21T-1F281.*

*Received 06.04.2022*
*Reviewed 11.05.2022*
*Accepted 25.05.2022*

## REFERENCES

1. Kopytina N.I., Andreyeva N.A. Microbiological Studies of Indoor Air in a Swimming Pool with Dolphins. *Ecosystems* **9** (2017), 57–66 (in Russian).
2. Marfenina O.E. Fomicheva G.M. Potentially Pathogenic Filamentous Fungi in the Human Environment. Modern Trends. Mycology Today (eds. By Yu.T. Dyakov). Moscow, National Academy of Mycology **1** (2007), 235–266 (in Russian).
3. Vujanovic V., Smoragiewicz W., Krzysztyniak K. Airborne Fungal Ecological Niche Determination as One of the Possibilities for Indirect Mycotoxin Risk Assessment in Indoor Air. *Environ. Toxicol.* **16** (2001), 1–8.
4. Green B.J., Sercombe J.K., Tovey E.R. Fungal Fragments and Undocumented Conidia Function as New Aeroallergen Sources. *J. Allergy. Clin. Immunol.* **115** (2005), 1043–1048.
5. Caggiano G., Napoli C., Coretti C., et al. Mold Contamination in a Controlled Hospital Environment: a 3-year Surveillance in Southern Italy. *BMC Infect. Dis.* **14** (2014), 595–599.
6. Božić, J. Ilić P., Ilić S. Indoor Air Quality in the Hospital: The Influence of Heating, Ventilating and Conditioning Systems. *Brazilian Archives of Biology and Technology* **62** (2019), 1–11. https://doi.org/10.13140/RG.2.2.15905.35684
7. Turbina I.N., Gorban M.V., Yampolskaya T.D. Use of Interior Plants for Sanitation the Air in Apartments of Different Types. *Bulletin of the Samara Scientific Center of the Russian Academy of Sciences* **17** (2015), 229–232 (in Russian).
8. Adewusi E.A., Afolayan A.J. Antibacterial, Antifungal and Antioxidant Activity of the Roots and Leaves of *Pelargonium Reniforme* Curtis (Geraniaceae). *African Journal of Biotechnology* **8** (2009), 6425–6433. http://www.academicjournals.org/AJB
9. Karamova N.S., Nadeyeva G.V., Bagayeva T.V. *Methods for the Study and Evaluation of Biodamages Caused by Microorganisms* (Educational and Methodological Manual). Kazan University (2014), 36 p. (in Russian).
10. Tsybulya N.V., Fershalova T.D., Davidovich L.P. The Use of Tropical Plants for Air Sanitation in Environmentally Unfavorable Indoor Conditions. *Bulletin of the Samara Scientific Center of the Russian Academy of Sciences* **19** (2017), 360–364 (in Russian).
11. Milko A.A. *Atlas of Mucoral Fungi*. Kiev (1971), 115 p. (in Russian).
12. Egorova L.N. *Soil Fungi of the Far East*. Leningrad (1986), 191 p. (in Russian).
13. Bilay V.I., Koval E.Z. *Aspergillus*. Kiev, Naukova dumka (1988), 204 p. (in Russian).
14. Koval E.Z., Rudenko A.V., Voloshuk N.M. *Penicillium*. Kiev, NNIRXV (2016), 407 p. (in Russian)

15. Matevosyan R.E., Nanagulyan S.G., Eloyan I.M., Yesayan T.A. Study of Soil Fungi in the Territory of Kapan City and Their Surrounding. *Proceedings of the YSU. Chemical and Biological Sciences* **52** (2018), 193–197. https://doi.org/10.46991/PYSU:B/2018.52.3.193
16. Suleymanova Z.N. Using Tropical and Subtropical Plants to Improve Indoor Air Quality. *OSU Bulletin* **6** (2009), 519–522 (in Russian).
17. Getko N., Ladyzhenko T., Shutova A. Phytoncidal Activity of Greenhouse Plants. *Science and Innovation* **5** (2014), 18–20 (in Russian).

Ա. Վ.ՊՈՂՈՍՅԱՆ, Ի. Մ. ԷԼՈՅԱՆ, Ռ. Գ. ԱԴԱՄՅԱՆ, Ա. Մ. ՊԵՏՐՈՍՅԱՆ,
Լ. Վ. ՄԱՐԳԱՐՅԱՆ, Ս. Գ. ՆԱՆԱԳՅՈՒԼՅԱՆ

## ՓԱԿ ՏԱՐԱԾՔՆԵՐԻ ՕԴԻ ՄԻԿՈԲԻՈՏԱՅԻ ՎՐԱ *PELARGONIUM GRAVEOLENS* L'HER. ԲՈՒՅՍԻ ԱԶԴԵՑՈՒԹՅՈՒՆԸ

Փակ տարածքներում միկրոօրգանիզմներով օդի աղտոտվածության աստիճանի նվազեցումը կարևորագույն խնդիրներից է: Բարձր ֆիտոնցիդային ակտիվությամբ օժտված սենյակային բույսերը ցուցաբերում են հակասնկային ազդեցություն: Աշխատասենյակի օդի մանրադիտակային սնկերով աղտոտվածության աստիճանի նվազեցման համար օգտագործել ենք *Pelargonium graveolens* L'Her. սենյակային բույսը, Geranium essentiale oil եթերայուղը: Հետազոտության արդյունքները ցույց տվեցին, որ միկրոմիցետներով օդի աղտոտվածության աստիճանը նվազել է *Pelargonium graveolens* բույսի առկայության դեպքում 3 անգամ, իսկ բույսի և եթերայուղի դեպքում՝ 4 անգամ:

А. В. ПОГОСЯН, И. М. ЭЛОЯН, Р. Г. АДАМЯН, А. М. ПЕТРОСЯН,
Л. В. МАРГАРЯН, С. Г. НАНАГЮЛЯН

## ВОЗДЕЙСТВИЕ *PELARGONIUM GRAVEOLENS* L'HER. НА МИКОБИОТУ ВОЗДУХА ЗАКРЫТЫХ ПОМЕЩЕНИЙ

Снижение уровня заспоренности микромицетами воздуха закрытых помещений является одной из важнейших проблем. Комнатные растения с высокой фитонцидной активностью оказывают противогрибковое воздействие. Для снижения уровня заспоренности воздуха рабочего кабинета использовались комнатное растение *Pelargonium graveolens* L'Her. и эфирное масло герани. Результаты данных исследований показали, что высокая заспоренность воздуха при наличии комнатного растения *Pelargonium graveolens* уменьшилась в 3 раза, а при сочетании *P. graveolens* с эфирным маслом герани – в 4 раза.