

MYCOBIOTA OF SELECTED PLANTS IN AZERBAIJAN: COMPARATIVE TAXONOMIC AND ECOLOTROPHIC ANALYSIS

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Abstract

Microscopic fungi represent a critical component of plant-associated microbiota, influencing both natural and agroecosystems through pathogenic, saprotrophic, and mutualistic interactions. The present study provides a comparative analysis of the mycobiota associated with selected plants growing under contrasting ecological conditions in Azerbaijan: medicinal plants (*Urtica dioica* L., *Stellaria media* L., and *Cephalaria gigantea* (Ledeb.) Bobrov) naturally occurring in the montane Gadabay region, and cotton (*Gossypium hirsutum* L.) cultivated under irrigated semi-arid conditions in the Aran Karabakh lowland. Fungal isolates were recovered using standard culture-based techniques on YGC and DG18 agar media, followed by morphological and microscopic identification. Results revealed dominance of Ascomycota (66–70%) in both plant systems, with Zygomycota comprising the remainder. Key genera identified included *Aspergillus*, *Penicillium*, *Alternaria*, *Fusarium*, *Cladosporium*, *Mucor*, and *Rhizopus*. Ecolotrophic assessment showed prevalence of pathogenic and saprotrophic forms, particularly in stressed tissues. The findings underscore the importance of systematic mycological monitoring for both medicinal plant safety and cotton agroecosystem health in Azerbaijan.

Keywords: mycobiota; micromycetes; Ascomycota; medicinal plants; cotton; Azerbaijan; ecolotrophic structure; phytopathogens

1. Introduction

Microscopic fungi are ubiquitous constituents of terrestrial plant communities, occupying diverse ecological niches as pathogens, saprotrophs, endophytes, and mutualists. Their composition and functional diversity are shaped by host plant biology, climate, soil properties, and land use intensity. Understanding mycobiota structure is essential not only for ecological research, but also for ensuring the biological safety of plant-derived products and the sustainability of agricultural systems (Compant et al., 2021; Namazov & Sultanova, 2015).

Azerbaijan presents a wide range of ecological zones, from high-elevation mountain forests and meadows to lowland semi-arid irrigated plains. The Gadabay district of the Lesser Caucasus is characterized by rich floristic diversity, mild-temperate climate, and abundant natural vegetation, providing habitat for numerous wild medicinal plants. In contrast, the Aran Karabakh lowland, situated in the Kura–Araz depression, is defined by a hot, dry subtropical climate, alluvial-meadow soils, and irrigation-dependent intensive agriculture, particularly cotton cultivation (*Gossypium hirsutum* L.).

Although fungi associated with both medicinal plants and cotton have been studied globally, region-specific mycological investigations in Azerbaijan remain limited. The present study bridges this gap by conducting a unified comparative study of mycobiota in these two contrasting ecological and agricultural contexts, with a focus on taxonomic composition and ecolotrophic differentiation.

2. Materials and Methods

2.1 Study Objects and Sampling. Field samples were collected from two geographically distinct regions of Azerbaijan. In the Gadabay region (Lesser Caucasus, elevation 700–2000 m a.s.l.), three medicinal plant species were sampled: *Urtica dioica* L., *Stellaria media* L., and *Cephalaria gigantea* (Ledeb.) Bobrov. Plants were

collected from natural vegetation sites during the active vegetative period; both visibly healthy and affected organs were included. In the Aran Karabakh lowland, samples were taken from three commercial cotton (*Gossypium hirsutum* L.) fields during the vegetative growth stage. Leaves, stems, and bolls of healthy and stressed plants were collected aseptically.

2.2 Fungal Isolation and Identification. Fungal isolation was carried out using conventional mycological methods. Plant fragments were aseptically placed on YGC (Yeast Extract-Glucose-Chloramphenicol) and DG18 (Dichloran-Glycerol) agar media and incubated at 25–27 °C for five days. Colony development was monitored daily; pure cultures were obtained by subculturing. Identification of isolates was based on macroscopic colony characteristics (morphology, pigmentation, growth rate) and microscopic structures (conidia, hyphae, sporulation structures) examined by light microscopy, with reference to international mycological keys and databases.

2.3 Statistical Analysis. The frequency of fungal occurrence (P) was calculated as $P = (n/N) \times 100$, where n is the number of positive samples and N is the total number of samples. Distribution density was estimated as $N = n/s$ (units per hectare). All experiments were conducted in triplicate; statistical reliability was assessed using Student's t-test at significance level $P \leq 0.05$.

3. Results

A total of more than 15 fungal species were isolated from medicinal plants (Gadabay), and more than 18 species from cotton (Aran Karabakh). In both systems, the phylum Ascomycota dominated, comprising approximately 66% of taxa in medicinal plants and ~70% in cotton. Zygomycota (primarily Mucorales) accounted for the remainder (Table 1).

Table 1.

Comparative mycobiota structure of medicinal plants (Gadabay) and cotton (Aran Karabakh), Azerbaijan.

Parameter	Medicinal Plants (Gadabay)	Cotton (Aran Karabakh)	Common Genera
Total taxa	>15 species	>18 species	Aspergillus, Penicillium, Fusarium
Ascomycota (%)	~66%	~70%	Alternaria, Cladosporium
Zygomycota (%)	~34%	~30%	Mucor, Rhizopus, Syncephalastrum
Dominant pathogen	Alternaria, Fusarium	Fusarium, Alternaria	—
Predominant ecogroup	Saprotrophic, Pathogenic	Pathogenic, Saprotrophic	—

In the Gadabay medicinal plant mycobiota, the dominant genera were *Aspergillus* and *Penicillium* (Ascomycota), and *Mucor*, *Rhizopus*, and *Syncephalastrum* (Zygomycota). Pathogenic fungi were predominantly associated with senescent, mechanically damaged, or physiologically stressed tissues. In the Aran Karabakh cotton agroecosystem, *Fusarium* species were frequently isolated from root and stem tissues, correlating with vascular discoloration and wilting symptoms. *Alternaria* and *Cladosporium* were mainly detected on leaf surfaces, particularly in senescent tissue. Saprotrophic fungi were common in damaged bolls and post-harvest residues.

4. Discussion

The dominance of Ascomycota across both plant systems is consistent with global mycological surveys and reflects the broad ecological plasticity of ascomycetous fungi (Compant et al., 2021; Zhang et al., 2019). *Aspergillus* and *Penicillium* are recognized as ubiquitous saprotrophs and opportunistic colonizers capable of producing mycotoxins under favorable conditions, posing risks to the safety of medicinal plant raw materials (Namazov & Sultanova, 2015). In the agroecosystem context, *Fusarium* species represent destructive soil-borne pathogens surviving for extended periods in crop residues, a pattern consistent with observations from semi-arid cotton systems globally (Wang et al., 2022).

A key difference between the two systems lies in the ecological drivers of fungal colonization. In the Gadabay natural setting, plant stress was primarily associated with physiological senescence and mechanical damage in unpredictable montane climate conditions. In the Aran Karabakh agroecosystem, high summer temperatures, water stress, and intensive cultivation practices were the principal factors promoting fungal persistence and dispersal. These contrasting environments yielded similar phylum-level compositions but distinct genus-level assemblages, highlighting the role of local ecological filters in shaping mycobiota.

Ecolotrophic analysis revealed that saprotrophic and pathogenic functional groups dominate in both systems, while mutualistic (endophytic) associations were less prevalent. The relatively low endophyte diversity may reflect either actual ecological constraints or limitations of culture-based isolation methods, which tend

to underestimate endophytic communities. Future studies integrating molecular (metabarcoding) approaches would provide more comprehensive data.

5. Conclusions

This comparative study demonstrates that the mycobiota of both wild medicinal plants in the Gadabay montane region and cultivated cotton in the Aran Karabakh lowland of Azerbaijan are dominated by Ascomycetous fungi, primarily genera with pathogenic and saprotrophic ecolotrophic roles. Despite contrasting ecological and agricultural contexts, both systems showed similar phylum-level structure (~66–70% Ascomycota) with distinct genus-level composition shaped by local environmental conditions.

The findings emphasize the need for systematic mycological monitoring in both contexts: to ensure the hygienic quality and biological safety of medicinal plant materials, and to support integrated phytosanitary management in cotton agroecosystems. Expanding such investigations across Azerbaijan's diverse ecological zones would contribute to a national baseline dataset for plant mycobiota.

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