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Mycobiome: The success of molecular communication in symbiosis

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1. INTRODUCTION

Mycobiome (or fungal microbiome) refers to the community of fungi in symbiosis within a microbiome inside the holobiont. It is a distinct component of the microbiota, which also includes bacteria, viruses, and archaea [1]. Although fungi typically constitute a minority of the total microbial community compared with bacteria, they play critical roles in human and plant health, including immune system modulation, metabolic function, maintaining microbial balance, and pest control [2]. In this way, the plant mycobiome is the total community of fungi that live on, inside, and around a plant, including those found in the soil (rhizosphere), on plant surfaces (phyllosphere), and inside plant tissues (endophytes) (Fig. 1) [3,4]. Ascomycota are the largest group, with the highest abundance in leaf endophytes and moulds. Basidiomycota are also frequently present and include wood-degraders, rusts, and root-associated symbionts [5]. These fungal communities improve plant growth, nutrient sharing, and disease resistance. In addition, this fungal network includes friendly partners, harmless neighbors, and hidden germs. It improves plant health, strength against abiotic stress, and food safety [6]. In this context, the soil microbiome is a complex community of microorganisms, including bacteria, fungi, archaea, protists, and viruses, that inhabits the soil and is critical for maintaining the health of ecosystems [7]. One gram of soil can contain up to 10 billion microorganisms in interaction, where the highest density is found in the rhizosphere (the region around plant roots), due to carbon-rich root exudates [8]. In addition, in the rhizosphere, glomalin is produced, which is a sticky glycoprotein produced by arbuscular mycorrhizal fungi (AMF) in the phylum Glomeromycota. This glycoprotein acts as a cohesive glue that binds soil particles together, stores carbon, and builds stable soil structures that help to prevent erosion [9]. Therefore, the soil mycobiome forms a fungal network that drives a polymicrobial communication system and nutrient acquisition cycle. Furthermore, these fungal communities interact with the entire plant holobiont microbiome to preserve ecosystem stability, plant health, and soil resilience to changes in natural environments [10]. So, fungal symbiosis within this network, especially in mycorrhizal associations, involves a mutual exchange in which fungi supply plants with water and minerals such as phosphorus in exchange for photosynthetic sugars, in a kind of underground network that improves nutrient cycling, soil structure, and plant health [11]. Furthermore, among the mechanisms of fungal symbiosis is nutrient exchange, by which fungal hyphae and mycelium mine the soil in search of immobile nutrients (nitrogen and phosphorus) that the roots cannot reach independently. Additionally, there is the wood wide web, in which mycelial networks connect multiple plants, enabling cooperative resource sharing and defense signaling between plant holobiont communities [12]. Furthermore, the phenomenon of bacterial endosymbiosis is present, in which many soil fungi can harbor internal bacteria that produce secondary metabolites, in evolutionary cooperation, protecting the fungal host from predators or environmental stress in a kind of holobiontic relationship [13]. In this game of vital symbiosis, fungi colonize plant roots, exchanging water and absorbed nutrients such as phosphorus for plant sugars, while glomalin binds soil particles together to build a healthy and stable soil structure. In this way, glomalin joins small pieces of soil into stable groups, stopping erosion caused by wind and water. It locks carbon safely into the soil, helping to combat climate change. Furthermore, it protects the roots against heavy metals and harsh soil conditions [14]. Likewise, fungal dysbiosis caused by chemical pesticides causes alterations in the mycobiome in crops and the resilience of ecosystems by altering nutrient cycling, weakening root mutualisms, and blocking hormonal signals necessary to adapt to drought, heat, and salinity [15]. Therefore, maintaining and restoring the symbioses that make up the mycobiome helps sustainable agriculture by repairing soil health, boosting plant growth, and reducing the massive use of pesticides [16]. In this way, the fungi present in the mycobiome also drive adaptive processes within plants, which improve adaptability to abiotic stress caused by climate change. Because of this, these organisms change the plants' genetic activity and epigenetic responses, using chemical signals. This support allows plants to respond quickly to adverse weather conditions, droughts, or soil changes without waiting for slow genetic adaptations over several generations [17]. Therefore, restoring the plant mycobiome network using bioinoculants involves applying selected fungal strains, such as specific AMF, to reestablish chemical signaling and symbiosis with native endophytes and mycorrhizae. Through this integration, these bioinoculants release phytohormones, volatile organic compounds, and enzymes that trigger mutualistic signals, ultimately optimizing nutrient absorption, plant health, and soil resilience [18]. Therefore, the establishment of multistrain consortia suppresses pathogens and restores functional microbial networks in degraded soils. Similarly, bioinoculants can be applied through seed coatings, root dipping, or direct incorporation into the soil [19]. Therefore, the crop mycobiome refers to the total community of fungi living on or within plant tissues (yeasts, moulds, and fungi) that live symbiotically either on the surface (epiphytes) or inside (endophytes) plant tissues, interacting to control the pathobiome, which is the expanded disease-causing network where a primary pathogen interacts with the

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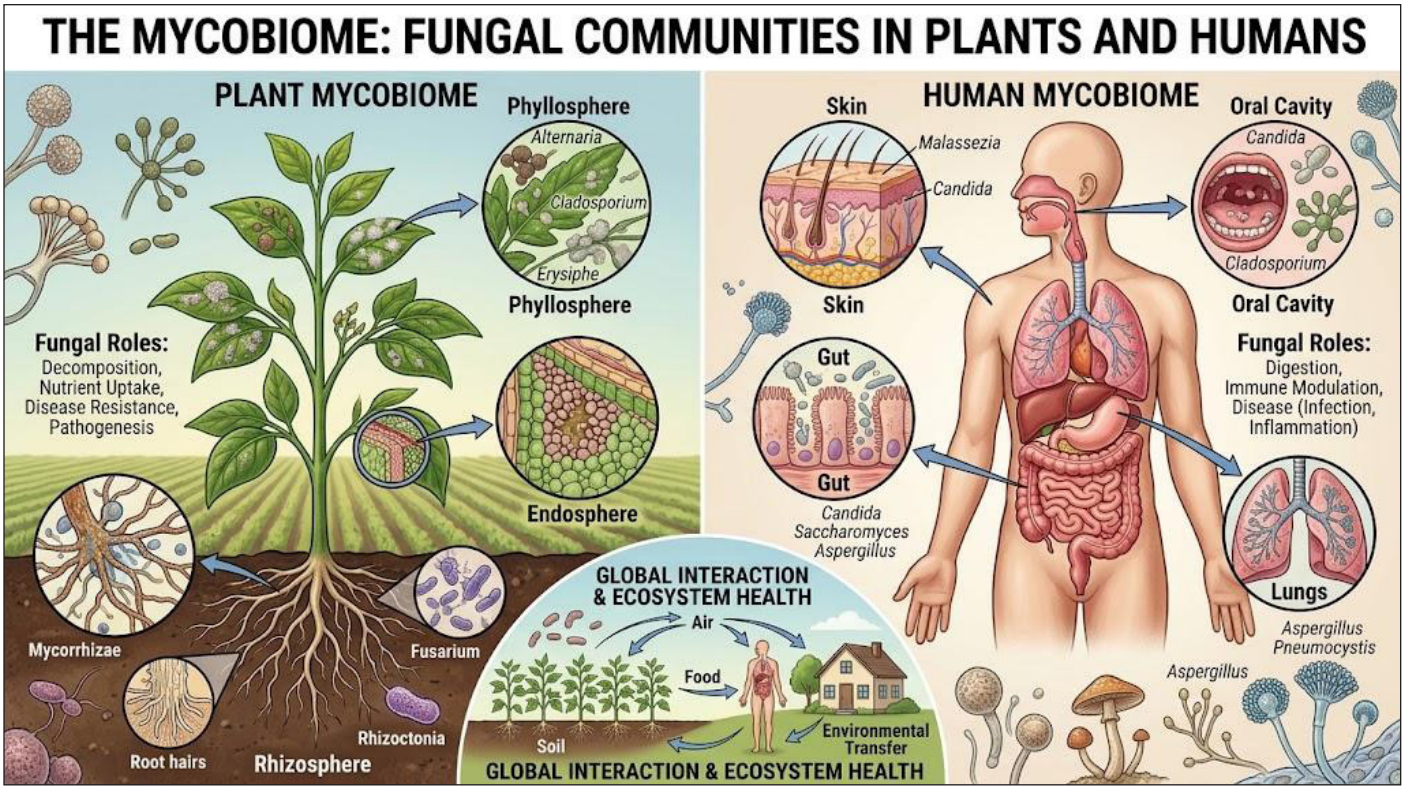

Figure 1. Mycobiome: fungal communities in plants and humans.

surrounding microbial community to influence the development of symptoms due to dysbiosis that causes disruption of the mycobiome [20]. Together, they change plant pathology from viewing diseases as caused by a single isolated microbe to a modern concept that dysbiosis is a disease, due to the loss of microbial diversity. Thus, in the interaction between symbionts and pathobionts within the holobiont (a host and all its companion living microbes, such as bacteria and fungi, acting together), the molecular communication networks established between the mycobiome and the microbiome allow maintaining a balance that ensures that plants are not susceptible to pests (Fig. 1) [21,22]. Therefore, the plant mycobiome and bacterial biofilms interact extensively on root and leaf surfaces, where fungi provide physical support networks and chemical signals that increase multispecies community assembly, nutrient exchange, and host stress survival. In this way, fungal hyphae and mycelium provide stable surfaces that bacteria use to colonize and spread mixed-species biofilms along plant roots [23]. Furthermore, fungi and bacteria exchange metabolic signals, such as amino acids and autoinducers, that stimulate or inhibit extracellular polymeric substance matrix production. Additionally, fungal networks solubilize minerals while adjacent bacterial biofilms fix nitrogen or cycle carbon, improving overall availability to the host [24]. Furthermore, some members of the mycobiome synthesize secondary metabolites that disrupt pathogenic biofilms, while others cooperate with beneficial bacteria to enhance systemic resistance. The benefits of this interaction include increased drought and salinity tolerance through moderate root hydration and stress hormone regulation. Furthermore, it enhances pathogen inhibition by blocking colonization sites in plant tissues and increases nutrient uptake efficiency through the combined activity of the rhizosphere [25]. In this way, strengthening the mycobiome in plants, soil and the environment directly aligns with the One Health strategy supported by the World Health Organization. This holistic framework recognizes that maintaining microbial balance, or eubiosis, in natural systems and ecosystems is vital for both planetary and public health [26]. Additionally, it integrates microbial health into interconnected domains of One Health, in which plant, soil and environmental microbiomes act as biological bridges that affect broader ecological and nutritional outcomes [27].

2. CONFLICTS OF INTEREST

The authors report no financial or other conflicts of interest in this work.

3. PUBLISHER'S NOTE

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The authors declare that they have not used artificial intelligence (AI) tools for writing and editing of the manuscript, and no images were manipulated using AI.

REFERENCES

1. Mohammadi R, Morovati H, Safari F. The human mycobiome: a critical yet understudied component of health and disease. Microbiology 2025;171(12):001631;doi: https://doi.org/10.1099/mic.0.001631

2. El Jaddaoui I, Sehli S, Al Idrissi N, Bakri Y, Belyamani L, Ghazal H. The gut mycobiome for precision medicine. J Fungi 2025;11(4):279; doi: https://doi.org/10.3390/jof11040279
3. De Mandal S, Jeon J. Phyllosphere Microbiome in plant health and disease. Plants 2023;12(19):3481; doi: https://doi.org/10.3390/plants12193481
4. Salamon S, Mikołajczak K, Błaszczyk L. Constellation of the endophytic mycobiome in spring and winter wheat cultivars grown under various conditions. Sci Rep. 2023;13:6089;doi: https://doi.org/10.1038/s41598-023-33195-y
5. Rungjindamai N, Jones EBG. Why are there so few Basidiomycota and basal fungi as endophytes? A review. J Fungi (Basel). 2024;10(1):67; doi: https://doi.org/10.3390/jof10010067
6. Ullah A, Gao D, Wu F. Common mycorrhizal network: the predominant socialist and capitalist responses of possible plant–plant and plant–microbe interactions for sustainable agriculture. Front Microbiol 2024;15:1183024; doi: https://doi.org/10.3389/fmicb.2024.1183024
7. Panek J, Gryta A, Maj W, *et al.* Plant–soil–microbiome interactions: mechanisms, advances, and challenges in sustainable agriculture and healthy agroecosystems. Front Microbiol 2026;17:1762743;doi: https://doi.org/10.3389/fmicb.2026.1762743
8. Kiprotich K, Muema E, Wekesa C, *et al.* Unveiling the roles, mechanisms and prospects of soil microbial communities in sustainable agriculture. Discov Soil. 2025;2:10;doi: https://doi.org/10.1007/s44378-025-00037-4
9. Iqbal S, Begum F, Nguchu BA, Claver UP, Shaw P. The invisible architects: microbial communities and their transformative role in soil health and global climate changes. Environ Microbiome. 2025;20(1):36; doi: https://doi.org/10.1186/s40793-025-00694-6
10. Mosca S, Francomano E, Aci MM, Mohamed NZ, Schena L, Malacrinò A. Beneficial fungi as major drivers of root fungal microbiome assembly and network robustness across a soil disturbance gradient. Appl Soil Ecol 2026;225:107187;doi: https://doi.org/10.1016/j.apsoil.2026.107187
11. Figueiredo AF, Boy J, Guggenberger G. Common mycorrhizae network: a review of the theories and mechanisms behind underground interactions. Front Fungal Biol 2021;2:735299; doi: https://doi.org/10.3389/ffunb.2021.735299
12. Martin FM, van der Heijden MGA. The mycorrhizal symbiosis: research frontiers in genomics, ecology, and agricultural application. New Phytol. 2024;242(4):1486–1506; doi: https://doi.org/10.1111/nph.19541
13. Gassler T, Giger GH, Sintsova A, *et al.* Induced endosymbiosis between a fungus and bacterium reveals a shift from antagonism to commensalism. Nat Commun 2025;16(1):10717; doi: https://doi.org/10.1038/s41467-025-65741-9
14. Huey CJ, Gopinath SCB, Uda MNA, *et al.* Mycorrhiza: a natural resource assists plant growth under varied soil conditions. 3 Biotech. 2020;10(5):204;doi: https://doi.org/10.1007/s13205-020-02188-3
15. Yiallouris A, Pana ZD, Marangos G, *et al.* Fungal diversity in the soil mycobiome: Implications for ONE health. One Health 2024;18:100720; doi: https://doi.org/10.1016/j.onehlt.2024.100720
16. Orozco-Mosqueda MC, Glick BR, Santoyo G. Cross-talk within plant niches: endophytic and arbuscular mycorrhizal fungi for sustainable crop production. FEMS Microbiol Rev 2025;50:fuaf063; doi: https://doi.org/10.1093/femsre/fuaf063
17. Fadiji AE, Yadav AN, Santoyo G, Babalola OO. Understanding the plant-microbe interactions in environments exposed to abiotic stresses: an overview. Microbiol Res 2023;271:127368; doi: https://doi.org/10.1016/j.micres.2023.127368
18. Vera L, Retamal-Salgado J, Tortella G, Santoyo G, Schoebitz M. Functional roles of arbuscular mycorrhizal fungi and plant growth-promoting rhizobacteria in Pistachio: implications for stress tolerance, nutrient acquisition and disease suppression. Plants 2026;15(17):2575; doi: https://doi.org/10.3390/plants15172575
19. Niu B, Wang W, Yuan Z, *et al.* Microbial interactions within multiple-strain biological control agents impact soil-borne plant disease. Front Microbiol 2020;11: 585404; doi: https://doi.org/10.3389/fmicb.2020.585404
20. Ansari RA, Egamberdievich KE, Raximovna MT, *et al.* Phytomycobiomes and ecosystem services: mechanisms, evidence and routes to application. J Fungi 2025;12(1):1;doi: https://doi.org/10.3390/jof12010001
21. Jędryczka M, Bełka M, Berg G, *et al.* Soil pathobiome in agroecosystems and forests. Plant Pathol. 2026;75(4):e70261; doi: https://doi.org/10.1111/ppa.70261
22. Penton CR, Vadakattu G. The root rhizosphere as a functional analog to the gut microbiome: cases for microbial symbiosis and dysbiosis in parallel contexts. PNAS Nexus. 2026;5(5):pgag132; doi: https://doi.org/10.1093/pnasnexus/pgag132
23. Bortolot M, Buffoni B, Mazzarino S, *et al.* The Importance of mycorrhizal fungi and their associated bacteria in promoting crops' performance: an applicative perspective. Horticulturae 2024;10(12):1326; doi: https://doi.org/10.3390/horticulturae10121326
24. Gao J, Dong A, Li J, Xu J, Liang Z, Logrieco AF. Exploring fungal communication mechanisms in the rhizosphere microbiome for a sustainable green agriculture. J Fungi 2025;11(10):726; doi: https://doi.org/10.3390/jof11100726
25. Du Y, Han X, Tsuda K. Microbiome-mediated plant disease resistance: recent advances and future directions. J Gen Plant Pathol 2025;91(1):1–17; doi: https://doi.org/10.1007/s10327-024-01204-1
26. Couradeau E, Martiny JBH, Fontaine F, *et al.* Incorporating microbiomes into the One Health Joint Plan of Action. mBio. 2025;16(10):e01456-25; doi: https://doi.org/10.1128/mbio.01456-25
27. Law SR, Mathes F, Paten AM, *et al.* Life at the borderlands: microbiomes of interfaces critical to One Health. FEMS Microbiol Rev 2024;48(2):fuae008;doi: https://doi.org/10.1093/femsre/fuae008

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