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COMPARATIVE DIVERSITY AND SPATIAL DISTRIBUTION OF FUNGI ON *HIBISCUS* SPP.

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ABSTRACT

This study evaluates the incidence, taxonomic diversity, and spatial distribution patterns of fungi colonising floral waste of *Hibiscus* spp. collected across ten distinct geographical localities (L1 to L10) in the Marathwada region of Maharashtra, India. A total of 32 fungal species belonging to 8 prominent genera were isolated and identified using Potato Dextrose Agar (PDA) medium. The mycobiota was dominated by the genera *Aspergillus* (10 species), *Penicillium* (7 species), *Alternaria* (3 species), *Cladosporium* (3 species), *Curvularia* (2 species), *Fusarium* (2 species), *Rhizopus* (2 species), *Trichoderma* (2 species), alongside the monotypic representatives *Lasiodiplodia theobromae* and *Nigrospora oryzae*. Ten fungal species demonstrated high ubiquitous occurrence (90% incidence, recorded across 9 of the 10 surveyed sites): *Alternaria raphani*, *Aspergillus niger*, *Aspergillus terreus*, *Cladosporium cladosporioides*, *Curvularia lunata*, *Fusarium fujikuroi*, *Lasiodiplodia theobromae*, *Nigrospora oryzae*, *Penicillium echinulatum*, and *Penicillium lilacinum*. Furthermore, the beneficial biocontrol antagonists *Trichoderma harzianum* and *Trichoderma viride* were recovered at spatial incidence of 70% and 60%, respectively. The pronounced fungal colonization reflects the high moisture and nutrient retention in discarded floral waste across varying microclimatic regimes. These findings establish essential empirical baselines for post-harvest phytosanitary management, environmental biosecurity, and the valorization of discarded *Hibiscus* floral biomass via solid-state fermentation and composting.

Keywords: Hibiscus Spp.; Fungal Diversity; Spatial Incidence; Floral Waste; Aspergillus; Trichoderma; Biodegradation

1 INTRODUCTION

Floriculture represents one of the most commercially dynamic and rapidly expanding sectors within modern horticultural biotechnology and agriculture (Chakraborty et al., 2021; Kumar et al., 2019). Ornamental flowers play a central role in aesthetic landscaping, social ceremonies, religious offerings, pharmaceutical formulations, and the cosmetic industry (Singh & Sharma, 2020). Among cultivated ornamental taxa, species belonging to the genus *Hibiscus* L. (family Malvaceae) hold paramount commercial, medicinal, and cultural significance across tropical and subtropical regions, especially within Indian Agro-ecosystems (Li & Ma, 2017; Rogers, 2019). The genus *Hibiscus* comprises over

200 species, with *Hibiscus rosa-sinensis*, *Hibiscus sabdariffa*, and *Hibiscus syriacus* being the most widely cultivated varieties (Mukadam et al., 2006). These taxa are valued not only for their vibrant, solitary blossoms in aesthetic landscaping but also for their high anthocyanin concentrations, edible calyces, bast fibers, organic acids, and bioactive polyphenols, which are utilized extensively in herbal therapeutics, natural food colorants, and pharmacology (Coyago-Cruz et al., 2024; Sharara, 2017). Due to the delicate parenchymatous nature of floral structures, high internal moisture content (water activity a_w > 0.95), non-lignified petal tissues, and rapid post-harvest metabolic turnover, discarded *Hibiscus* flowers serve as exceptionally receptive biological sinks for epiphytic, endophytic, and saprophytic microbial colonization (Li & Ma, 2017; Singh & Sharma, 2020). Floral organs possess thin cuticular waxes, secretory glandular trichomes, and delicate petal margins that are highly vulnerable to micro-fractures during harvesting, transportation, and post-consumer disposal (Kumar et al., 2019; Verma & Johri, 2020).

In Maharashtra, massive quantities of fresh *Hibiscus* blossoms are utilized daily in religious rituals, temple offerings, marriage ceremonies, and public decorations (Waghmare & Chavan, 2014). Following their utilization, thousands of metric tons of spent floral waste are discarded into municipal solid waste streams, public dumpsites, and urban water bodies (Rannem & Shinde, 2022). Unmanaged floral waste undergoes anaerobic putrefaction, generating offensive odors,, greenhouse gases, and potential human health hazards through the dispersal of allergenic airborne fungal spores (Verma & Johri, 2020). Conversely, from a circular bio-economy perspective, spent floral biomass is an abundant, carbon-rich, non-woody lignocellulosic feedstock suitable for rapid bio-composting, organic fertilizer production, and microbial enzyme production (Mukadam et al., 2006; Waghmare & Chavan, 2014). Despite the ubiquitous distribution of *Hibiscus* across the Marathwada region, systematic multi-location investigations profiling the spatial diversity, incidence frequency, and biocontrol co-occurrence on discarded floral biomass remain scarce. Therefore, the present investigation aims to systematically characterize the mycofloral assemblage colonizing *Hibiscus* spp. floral waste across ten distinct geographic localities (L1–L10) in Chhatrapati Sambhajinagar, establishing critical baseline data for floral waste pathology, environmental management, and bio-resource valorization.

2 MATERIALS AND METHODS

2.1 Study area and sample collection

Floral waste was gathered from various locations and different stages of flower development. These included function halls, community centres, aesthetic spots, decoration sites, markets, and cultural events. The waste was collected in sterilised paper bags and transported to the laboratory. Sampling sites spanned diverse human-made and microclimatic environments, including banquet halls, religious temples, parks, retail flower markets, and open cultural spaces. Samples were collected in sterilised polyethene and paper bags under aseptic conditions, carefully labelled, and immediately sent to the Seed Pathology and Fungal Biotechnology Laboratory at Dr Babasaheb Ambedkar Marathwada University for mycological analysis.

2.2 Culture media and sterilization

Isolation of fungi was carried out using standard semi-synthetic culture media:

2.2.1 Potato Dextrose Agar (PDA)

Peeled and diced potatoes (200.0 g), Dextrose (20.0 g), Agar-agar (18.0 g), distilled water (1000 mL); final pH adjusted to 5.6 ± 0.2.

Media were sterilised in an autoclave at 121°C and 15 psi for 20 minutes. To suppress bacterial contamination, media were supplemented with filter-sterilised streptomycin sulphate (100 µg/mL) prior to pouring into sterile Petri plates.

2.3 Isolation and purification of fungal taxa

Floral petals were excised, cut into pieces, and inoculated directly onto solidified PDA and CZA plates under laminar airflow. The inoculated Petri dishes were incubated in a biochemical incubator at 28 ± 2°C for 7 days. Emerging fungal colonies were subcultured onto fresh CZA slants and Petri plates using single-spore or hyphal-tip isolation techniques to obtain axenic pure cultures.

2.4 Fungal identification and characterization

Fungal identification involved analyzing both macro- and micro-morphological features. Macro characteristics included colony diameter, growth rate, texture, surface pigmentation, and reverse coloration, while micro traits encompassed hyphal septation, conidiophore structure, vesicle shape, phialide arrangement, conidial/spore size and ornamentation, and chlamydospore formation. Microscopic examination was carried out using lactophenol cotton blue mounts viewed under an advanced research light microscope. Taxonomic classification was verified using standard mycological keys

and manuals (Ellis, 1971; Gilman, 2001; Mukadam et al., 2006), with supplementary validation from the Agharkar Research Institute (ARI), Pune.

2.5 Calculation of percentage incidence

The spatial incidence of each isolated fungal species was calculated using the standard ecological frequency formula:

Percentage incidence (%) = (Number of locations with fungal occurrence/ Total no. of locations surveyed [10]) × 100

3 RESULTS AND DISCUSSION

Mycological analysis of *Hibiscus* floral waste across 10 distinct geographic stations (L1–L10) revealed rich fungal diversity, comprising 32 species across 8 genera (Table 1).

Table 1: Incidence and distribution of fungal species isolated from *Hibiscus* spp. across ten geographical locations

Sr. No.	Name of Fungal Species	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	Total Sites	Incidence (%)
1	*Alternaria dianthicola*	+	+	-	-	-	-	-	+	+	-	4	40%
2	*Alternaria longipes*	-	-	-	+	+	+	+	-	-	+	5	50%
3	*Alternaria raphani*	+	+	+	+	+	+	-	+	+	+	9	90%
4	*Aspergillus carbonarius*	-	-	-	+	-	-	+	-	-	-	2	20%
5	*Aspergillus flavus*	+	+	-	-	+	+	-	-	-	+	5	50%
6	*Aspergillus fumigatus*	-	-	+	+	-	-	+	+	-	-	4	40%
7	*Aspergillus nidulans*	+	-	-	-	+	+	-	-	+	-	4	40%
8	*Aspergillus niger*	+	+	+	+	-	+	+	+	+	+	9	90%
9	*Aspergillus oryzae*	+	-	-	-	+	-	-	+	+	+	5	50%
10	*Aspergillus sydowii*	-	+	+	+	-	-	+	-	-	-	4	40%
11	*Aspergillus terreus*	+	+	+	+	+	+	+	+	+	-	9	90%
12	*Aspergillus tubingensis*	+	+	+	+	-	-	-	-	-	+	5	50%
13	*Aspergillus versicolor*	-	-	-	-	+	+	+	+	-	-	4	40%
14	*Cladosporium chlorocephalum*	+	+	+	-	-	-	-	-	-	-	3	30%
15	*Cladosporium cladosporioides*	+	-	+	+	+	+	+	+	+	+	9	90%
16	*Cladosporium oxysporum*	+	+	-	-	-	-	-	+	+	-	4	40%
17	*Curvularia lunata*	-	+	+	+	+	+	+	+	+	+	9	90%
18	*Curvularia ovoidea*	+	+	-	+	-	-	+	-	-	+	5	50%
19	*Fusarium fujikuroi*	+	-	+	+	+	+	+	+	+	+	9	90%
20	*Fusarium oxysporum*	+	+	-	-	-	-	-	-	+	+	4	40%
21	*Lasiodiplodia theobromae*	-	+	+	+	+	+	+	+	+	+	9	90%
22	*Nigrospora oryzae*	+	+	+	+	+	+	+	+	-	+	9	90%
23	*Penicillium echinulatum*	+	+	+	+	+	+	+	-	+	+	9	90%
24	*Penicillium expansum*	+	-	-	-	-	-	+	+	+	+	5	50%
25	*Penicillium chrysogenum*	-	+	+	-	-	-	-	-	+	+	4	40%
26	*Penicillium corylophilum*	+	-	-	-	-	-	-	+	-	-	2	20%
27	*Penicillium lilacinum*	+	+	-	+	+	+	+	+	+	+	9	90%

28	*Penicillium maximum*	-	+	+	+	+	+	-	-	-	-	5	50%
29	*Rhizopus oryzae*	-	-	-	-	-	-	+	+	+	+	4	40%
30	*Rhizopus stolonifer*	+	+	-	+	-	+	+	-	-	-	5	50%
31	*Trichoderma harzianum*	+	-	+	+	-	-	+	+	+	+	7	70%
32	*Trichoderma viride*	+	+	+	-	-	-	+	-	+	+	6	60%

"+" indicates presence of fungal taxa; "-" indicates absence.

3.1 Taxonomic richness and generic distribution

The generic profile demonstrated marked diversity, with the genus Aspergillus exhibiting the highest intra-generic richness (10 species: A. carbonarius, A. flavus, A. fumigatus, A. nidulans, A. niger, A. oryzae, A. sydowii, A. terreus, A. tubingensis, A. versicolor), followed closely by Penicillium with 6 species (P. echinulatum, P. expansum, P. chrysogenum, P. corylophilum, P. lilacinum, P. maximum). The high prevalence of these anamorphic ascomycetes is attributed to their abundant production of xerotolerant, easily dispersed airborne conidia and an extensive secretome of pectolytic and cellulolytic enzymes (Gilman, 2001; Waghmare & Chavan, 2014).

3.2 Core ubiquitous taxa (90% incidence)

A distinctive core group of 10 fungal species exhibited exceptional ubiquity, occurring in 9 out of 10 sampling sites (90% incidence): *Alternaria raphani*, *Aspergillus niger*, *Aspergillus terreus*, *Cladosporium cladosporioides*, *Curvularia lunata*, *Fusarium fujikuroi*, *Lasiodiplodia theobromae*, *Nigrospora oryzae*, *Penicillium echinulatum*, and *Penicillium lilacinum.* The melanized dematiaceous species (*Alternaria, Cladosporium, Curvularia, Nigrospora*) possess thick, melanin-pigmented conidial walls that confer elevated resistance to solar UV radiation, desiccation, and ambient thermal fluctuations (Ellis, 1971). Meanwhile, aggressive necrotrophs such as *Lasiodiplodia theobromae* and *Fusarium fujikuroi* rapidly colonise damaged petal parenchyma by secreting phytotoxins and hydrolytic enzymes, resulting in rapid maceration of host tissue (Pandey & Dwivedi, 2018; Ponnusamy et al., 2021).

3.3 Occurrence of antagonistic biocontrol agents

Importantly, beneficial biocontrol fungi like *Trichoderma harzianum* (70% incidence) and *Trichoderma viride* (60% incidence) were consistently found in floral waste across most locations. These Trichoderma species are well known as aggressive mycoparasites and rapid competitors for space and nutrients (Harman et al., 2004). Their natural occurrence in floral waste residues offers an inherent microbial balance and underscores their potential as locally adapted bioinoculants for fast waste composting and organic biofertilizer production.

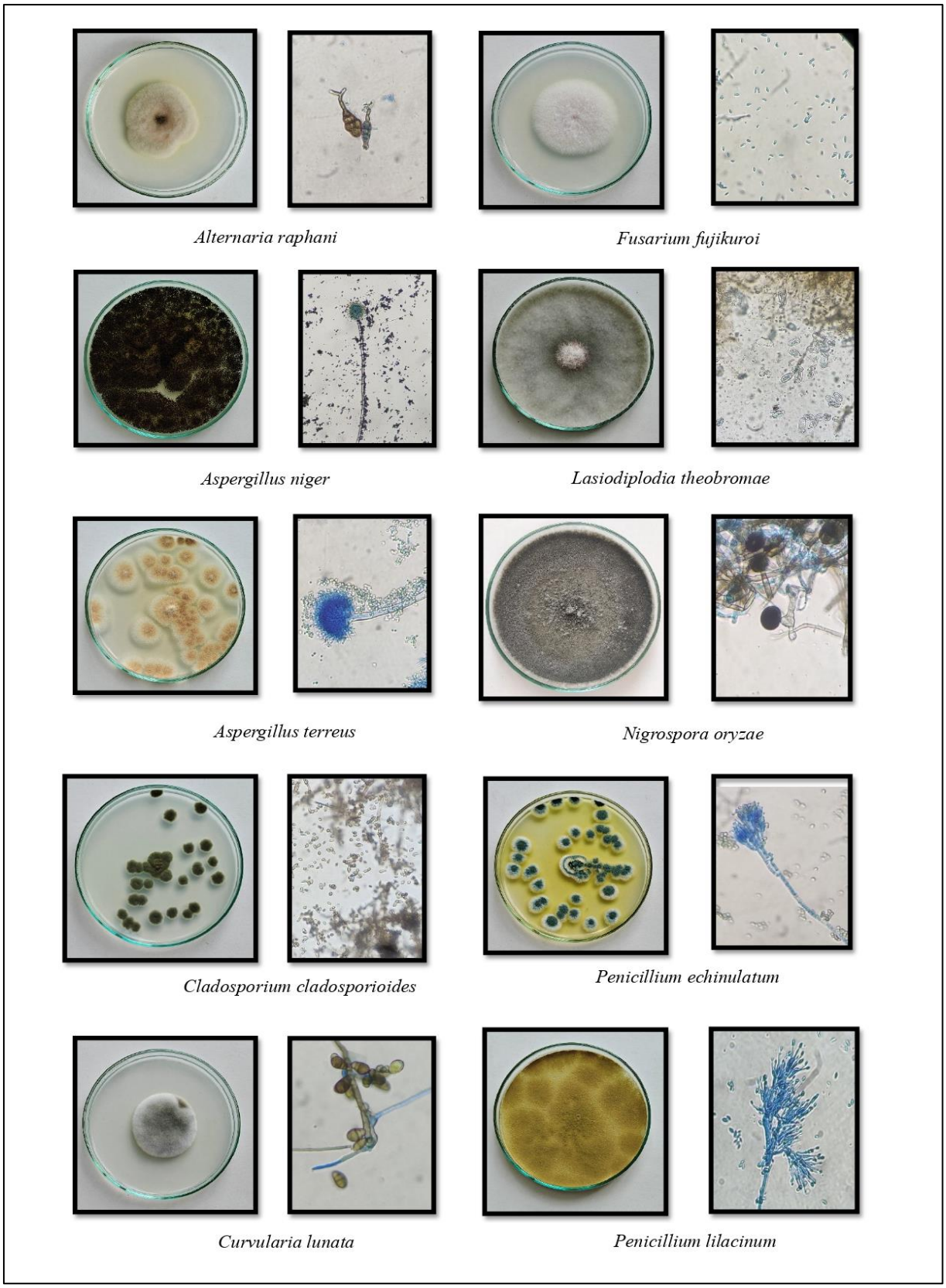

Figure 1: Microphotograph of some fungi

4 CONCLUSION

The present investigation demonstrates high fungal diversity (32 species across 8 genera) associated with discarded floral waste of *Hibiscus* spp. in the Marathwada region. The mycobiota is co-dominated by resilient saprophytic moulds (*Aspergillus* and *Penicillium* spp.), melanized airborne epiphytes (*Alternaria, Cladosporium, Curvularia*), opportunistic

phytopathogens (*Lasiodiplodia theobromae, Fusarium fujikuroi*), and naturally occurring biocontrol antagonists (*Trichoderma* spp.). Variations in fungal incidence across the ten survey stations reflect microclimatic differences, relative humidity levels, handling intensity, and ambient airborne spore loads. These baseline findings are vital for formulating effective post-harvest disease management strategies, mitigating environmental biosecurity risks associated with open dumping of flowers, and guiding the circular biotechnological valorization of *Hibiscus* floral biomass through rapid enzymatic composting and bio-fertilizer production.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

REFERENCES

[1] Chakraborty, A., Das, S., & Ghosh, R. (2021). Microbial load variations during floral developmental stages in ornamental crops. *Journal of Plant Microbiology*, 12(3), 145–153.

[2] Coyago-Cruz, E., Meléndez-Martínez, A. J., & Stinco, C. M. (2024). Bioactive compounds and antioxidant properties of *Hibiscus* species: A comprehensive review. *Phytochemistry Reviews*, 23(1), 112–129.

[3] Ellis, M. B. (1971). *Dematiaceous Hyphomycetes*. Commonwealth Mycological Institute, Kew, Surrey, England.

[4] Gilman, J. C. (2001). *A Manual of Soil Fungi* (2nd ed.). Biotech Books, New Delhi.

[5] Harman, G. E., Howell, C. R., Viterbo, A., Chet, I., & Lorito, M. (2004). *Trichoderma* species—opportunistic, avirulent plant symbionts. *Nature Reviews Microbiology*, 2(1), 43–56.

[6] Kumar, R., Patel, S., & Meena, V. (2019). Post-harvest fungal infections in commercial flowers: Impacts and management. *International Journal of Floriculture Science*, 7(2), 58–66.

[7] Li, X., & Ma, H. (2017). Biochemical changes during flower development and senescence in ornamentals. *Plant Physiology Reports*, 22(1), 34–42.

[8] Mukadam, D. S., Patil, M. S., & Chavan, A. M. (2006). *The Illustrated Kingdom of Fungi*. Saraswati Publishing, Aurangabad.

[9] Pandey, P., & Dwivedi, S. (2018). Diversity of fungal pathogens in floricultural crops and senescent tissues. *Mycological Research Letters*, 10(1), 25–32.

[10] Ponnusamy, K., Mohan, S., & Rajan, R. (2021). Opportunistic fungal pathogens in tropical ornamental crops. *Tropical Plant Pathology*, 46(2), 180–192.

[11] Rannem, S., & Shinde, B. (2022). Floral waste management and circular bio-economy potential in India: A review. *Journal of Environmental Management & Biotechnology*, 15(4), 310–322.

[12] Rogers, H. J. (2019). Senescence in flowers: Physiological processes and ecological significance. *Plant Biology Review*, 18(4), 210–223.

[13] Sharara, M. S. (2017). Characterization and potential of *Hibiscus* phytocompounds. *Journal of Agricultural Science and Botany*, 1(2), 15–21.

[14] Singh, A., & Sharma, P. (2020). Fungal colonization in high-moisture ornamental flowers: A review. *Asian Journal of Botanical Research*, 5(1), 12–20.

[15] Verma, S., & Johri, R. (2020). Airborne fungal spores and their interaction with floral tissues. *Environmental Botany Journal*, 9(2), 101–109.

[16] Waghmare, M. B., & Chavan, A. M. (2014). Biodegradation of temple floral waste by fungal flora. *International Journal of Current Microbiology and Applied Sciences*, 3(4), 814–820.