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THE POTENTIAL OF BAMBOO EXTRACTS FOR ANTIFUNGAL PROPERTIES

Mewada Thamoung

Email
mewada.thamoung@gmail.com

Wood Preservation discipline, Forest Products Division, Forest Research Institute, Dehradun, Uttarakhand - 248006, India

Bamboo, a remarkable family of giant woody grasses in the subfamily Bambusoideae of the Poaceae family, has long captured human interest for its incredible versatility. Extensively utilized for its strong and lightweight properties, bamboo serves essential roles in construction, furniture making, and handicrafts. Meanwhile, its tender shoots are processed into a variety of delicious foods and medicinal products. However, one of bamboo's most valuable components -the leaf has often been overlooked. Recent studies reveal their immense potential for antibacterial and antifungal properties, marking them as a promising area for exploration.

As one of the fastest-growing and most renewable resources, bamboo thrives in diverse climatic and edaphic conditions, establishing itself as a low-cost natural solution for countless applications. Beyond its practical uses, bamboo plays a vital role in rural society and the economy. Traditionally bamboo leaves are valued as feed for ruminants in regions where pasture is scarce which offers moderate levels of protein, total ash, and fiber lignin, making them a rich source of nitrogen supplements for livestock. Bamboo leaf ash, a byproduct with remarkable applications has shown promising results in stabilizing lateritic soil, enhancing portland cement mixtures, serving as a natural fertilizer, and even functioning as a natural pesticide.

Bioactive Compounds in Bamboo Leaves

Bioactive compounds normally accumulate in all parts of plants, but their concentration varies according to the part of plants. Different bamboo species and age groups also exhibit variations in the bioactive compounds. The main compounds found in bamboo leaves are phenolic acids, flavonoids, volatile oils, polysaccharides, long-chain fatty acids, derivatives of terpenes and amino acids, making them promising sources of natural

biologically active compounds. The complex volatile profiles of bamboo leaves give rise to various biological properties, including antifungal activity. Essential oils from leaves of *Phyllostachys pubescens* through gas chromatography-mass spectrometry (GC-MS) identified 39 volatile organic compounds (VOCs) which together accounted for 95.83% of the total constituents. Among these, hexadecanoic acid, phytol, and pentacosane emerged as the dominant components, highlighting the unique chemical profile of this bamboo species (Toan *et al.*, 2018). Similarly, extracts from *Bambusa blumeana* leaves revealed a rich array of bioactive compounds, including alkaloids, sterols, triterpenes, flavonoids, tannins, and phenols. Also, antifungal assay findings demonstrated that *B. blumeana* extracts have a comparable antifungal effect to fluconazole, a pharmaceutically approved antifungal agent at 1 mg/ml concentration (Saducos *et al.*, 2021).

Antifungal Properties

The diverse composition of bamboo leaves showcases potential for various applications, from natural remedies to sustainable agricultural practices but also underscores the importance of bamboo as a multifaceted resource in both traditional and modern contexts.

Table 1: Antifungal activity of some bamboo species

Species	Material basis	Methods	Results	References
Phyllostachys pubescens	Emulsion in water (EW)	Field test	Bamboo leaf extract showed anti-fungal activity against phytopathogens *Phytophthora capsici, Fusarium graminearum and Valsa mali* which has the potential to be developed into a broad-spectrum fungicide.	Liao *et al.*, 2021
Chimonocalamus delicatus	Aqueous ethanol (60:40, ethanol: water, *v*/*v*)	Antifungal Capacity Assays against *Colletotrichum musae, Botrytis cinerea* and *Alternaria alternata*	Extracts exhibited antifungal capacities against all three tested fungi but with a higher inhibitory capacity against *A. alternata* than *C. musae* and *B. cinerea*.	Shen *et al.*, 2024

Species	Material basis	Methods	Results	References
Dendrocalamus strictus Nees	Sterilized distilled water (Aqueous)	Disc diffusion method and agar well diffusion method	Efficient result against *Trichoderma viride.*	Patil *et al.*, 2016
Bambusa vulgaris	Chloroform n- Hexane, ethyl acetate, ampicillin, Gentamicin	Agar diffusion method	For *Aspergillus niger* minimum inhibitory concentrations (MIC): 2.5 ± 0.71, 1.25 ± 0.80, 2.5 ± 0.71, 0.31 ± 0.10, 0.31 ± 0.10 For *Verticillium alboatrum* MIC :2.5 ± 0.33, 5.0 ± 0.71, 1.25 ± 0.55 ,1.25 ± 0.77 , 2.5 ± 0.33	Owolabi *et al.*, 2015
Leaves of different bamboo species mix	Methanol, hexane, ethyl acetate, 1-butanol, and water.	Mycelia Growth Inhibition Test against *Pyricularia grisea*	Inhibitory Concentration (IC50) in mg/mL: 9.71 ^{a}, 0.62 ^{d}, 0.72 ^{c}, 0.81 ^{b}, 0.70 ^{c}	Toan *et al.*, 2018

Conclusion

Fungal diseases pose a significant threat to various sectors, particularly agriculture and forestry, leading to extensive losses and presenting major challenges to enhanced production. In agriculture, fungi can infect a wide range of crops, resulting in decreased yields and quality. In forestry, fungal pathogens can weaken trees and timber making them more susceptible to pests and environmental stressors. Synthetic chemical fungicides have many advantages but it ultimately hampers the environment. Natural products, such as bamboo leaf extracts, offer promising, eco-friendly options for managing plant diseases and preserving wood. By harnessing the antifungal properties of these natural resources, we can mitigate the adverse effects of fungal pathogens while promoting a healthier ecosystem and enhancing agricultural productivity.

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