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Antifungal activity of selected medicinal plants against the *Fusarium* species

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Abstract

In order to prevent *Fusarium* infections in the various crops, vegetables and other plants, the antifungal activities were investigated in the current study according to the agar diffusion technique. The plants that were chosen are *Pongamia pinnata* (L.) (Leaves), *Boerhavia erecta* (L.) (Whole plant), Cayratia trifolia (L.) (Whole plant), *Grewia hirsuta Vahl* (Leaves), *Convolvulus pentanthus (Jacq.) G. Don* (Whole plant). Water, dimethyl formamide, ethanol, acetone, isopropanol, and Toluene were among the solvents used to extract the plant samples using a Soxhlet apparatus. These solvent extracts were tested against several *Fusarium species*. The *Fusarium* fungus was significantly controlled and inhibited by the chosen plant extracts. Water, ethanol, acetone, dimethyl formamide isopropanol, and toluene extracts of selected plants were found to be inhibited different species of *Fusarium*. Water extract of *Pongamia pinnata* (L.) showed significant antifungal activity with MIC (Minimum inhibitory concentration) on *Fusarium oxysporum* (158 µg/ml), *Fusarium proliferatum* (130 µg/ml), and *Fusarium graminearum* (198 µg/ml). The all extracts *Boerhavia erecta* (L.) showed significant inhibition of mycelia growth in different species of Fusarium. Specifically water extract of *Boerhavia erecta* showed antifungal activity with MIC on *Fusarium proliferatum* (180 µg/ml), *Fusarium pseudocircinatum* (163 µg/ml), *Fusarium graminearum* (192 µg/ml), *Fusarium solani* (168 µg/ml), and *Fusarium moniliformae* (188 µg/ml). The antifungal activity of different plant extracts were compared with voriconazole as a standard antifungal agent.

Keywords: Plant extracts, Antifungal activity, *Fusarium* species, Crops, Vegetables, fruits etc.

1. Introduction

Fusarium infections are common and primarily linked to plant diseases. Due to crop losses caused by the presence of mycotoxin of food grains like wheat, Jawar, etc. they constitute a major financial issue in agriculture. In addition to being known to cause fungal infections in humans and animals, certain *Fusarium* species can cause a variety of clinical symptoms in people with weakened immune systems. Numerous plant species are infected by *Fusarium* fungi, which can result in symptoms such as stunted development, decaying of fruit or seeds, leaf and bark decaying and yellowing, as deterioration of roots or stems. Because of their propensity for pleomorphism, these fungi are challenging to identify. However, due to the high variety of the *Fusarium* genera, which has forced scientists to constantly update earlier taxa, molecular methods have proven to be quite effective in determining species and lineage thus far. Since fungus can readily bypass host susceptibility to different control approaches, *Fusarium* illnesses are often challenging to manage. In order to promote crucial research on comprehensive handling of this inevitable food contaminate and attain adequate world food safety, we also clarify different approaches for recognizing them.

Several species of *Fusarium* including *Fusarium graminearum* and *Fusarium oxysporum* are two of the most significant fungal diseases in plant diseases [1]. Numerous *Fusarium* species are harmful to a number of significant crops. Root or stem spoilage, scabs, vascular wilting, fruit decay, as well as diseases of leaves are some of the potential disease signs brought on by *Fusarium* species. Numerous crops, especially important food and commercial crops like wheat, oats, corn, bananas, and cotton are susceptible to a variety of diseases of plants caused by the majority of *fusarium* strains, which frequently have catastrophic socioeconomic effects [2].

Despite being an important part for food to animals as well as humans, fungal infections frequently target cereal crops. These illnesses are very hard to manage, frequently sneak up on you, and don't show any signs at first. Their diverse means of survival and dissemination, endophytic disease transmission, and broad host ranges all contribute to their efficacy as plant diseases. Examples can be found in both ecological and agricultural contexts in almost every bioclimatic zone of the planet . Additionally, new fungal infections have the potential to endanger ecological settings and food production. Because fungi can readily surpass host resistance, it is difficult to successfully control fungal illnesses [3]. One such strategy that has a lot to offer in terms of raising global yields of crops is the natural suppression of fungal infections [4].

*Fusarium*s have been around for more than two hundred years and are known to contain a variety of plant-pathogenic fungus species that are capable of generating severe infections. As frequent invaders of aerial plant parts, they can either be a natural element of the microbial fauna or they can serve as plant diseases on grains used in agriculture and horticulture crops, like maize, making them unfit for human consumption. At every stage of plant growth, *Fusarium* spp. can induce rot in the seedlings, roots, and crowns, as well as rot in the stalks and ears. From the time of infection to the host's reaction and disease progression, several tightly controlled processes are necessary for a *fusarium* infestation of plants to be efficient [5].

Controlling *fusarium* in crops is challenging since the physical, chemical, and agricultural methods for management are not only costly but also ineffectual. The following are a few explanations for the widespread distribution of *Fusarium* species: They are capable of growing and developing on a broad range of surfaces, and they have very effective spore dispersion mechanisms [6]. Since *Fusarium* is a soilborne phytopathogen, it may persist for several decades in plant detritus and soil. Animals and instruments used in the fields may spread the contaminated soil to other locations, causing outbreaks in previously unexplored regions. Numerous conditions in the environment are suitable for the survival of this fungus. However, insects serving as plant disease vectors are one of the less frequent ways that fungi spread, and recent research has shown that beetles may effectively spread the *Fusarium solani* species. The degree of yield decline depends on the location and quantity of the fungal culture in the field as well as the phases of plant development when the *Fusarium* illness manifests.

Fusarium thrives in growing environments that are generally warm and dry. In regions of the globe where crops are cultivated during these seasons, this presents a significant challenge. The persistent occurrence of *Fusarium* propagating on all live plant parts, plant wastes, and soils constitutes one of the difficulties in eliminating *Fusarium* in farming procedures [7].

In most regions of the globe, particularly in Asia, and in Europe, *Fusarium* is thought to be the most destructive fungus to agricultural plants. It seriously harms the host plant, impairing plant growth and lowering quality and output.

The global supply of food is now seriously threatened by *fusarium* infections of crops, which have been becoming worse over the past century. It has recently become clear that the most biotic threat to many of the world's major crops is *Fusarium* infections. They devastate commodity crops like bananas, coffee, and grain as well as vital nutritional crops like corn, maize, rice, groundnut, tomato and soybean. Due to its capacity to lower crop yields and taint plant based goods with toxins such as mycotoxins, *fusarium* contamination of cereals also has major economical and commercial ramifications for global food security. The problem of food insecurity is further increased by the fact that the loss of valuable crops to fungal infections destabilizes the economics of developing nations that depend on export earnings from the international commerce of these commodities to purchase food from other nations [8].

2. Methodology

Plant material:
The following plants has been collected from the Bhokar area of the District of Nanded and authenticated and confirmed by a taxonomist from Yeshwant Mahavidyalaya, Nanded, Maharashtra - 43102, using both internal and external characteristics: *Pongamia pinnata* (L.) (Leaves), *Boerhavia erecta* (L.) (Whole plant), *Cayratia trifolia* (L.) (Whole plant), *Grewia hirsuta* Vahl (Leaves), *Convolvulus pentanthus* (Jacq.) G. Don (Whole plant).

Plant extracts preparations:
The plants listed below have been obtained and let to dry in the shade. *Pongamia pinnata* (L.) (Leaves), *Boerhavia erecta* (L.) (Whole plant), Cayratia trifolia (L.) (Whole plant), *Grewia hirsuta Vahl* (Leaves), *Convolvulus pentanthus (Jacq.) G. Don* (Whole plant). After being allowed to air dry, the plant parts were ground into an extremely fine powder using a mixer grinder. The plants have been extracted from the extremely fine powder using the Soxhlet equipment together with a variety of solvents, including water, dimethyl formamide, ethanol, acetone, isopropanol, and toluene. Following the completion of the extraction procedure, which required seven cycles, the concentrated extract was stored in the refrigerator to usage in other studies.

Test microorganisms:
The test organisms tested during this investigation included *Fusarium oxysporum, Fusarium proliferatum, Fusarium pseudocircinatum, Fusarium graminearum, Fusarium solani*, and *Fusarium moniliformae*. A plant pathologist from Yeshwant Mahavidyalaya, Nanded, Maharashtra-43102, separated and identified them based on their morphology, spores, color, hyphae, and conidia after they were taken from fields and affected plant parts. Following that, the fungal cultures undergo several subcultures. Using various plants extracts from the chosen plants, antifungal effects have been examined.

Antifungal activity by agar diffusion method:
The agar well diffusion method was used to examine the antifungal abilities of different plant extracts. Several *Fusarium* fungus species inoculums were uniformly distributed on the sterile petriplates using solidifying potato dextrose agar medium. On each agar plate, three wells were made using a sterile cork borer. Various concentrations of the plant samples were applied to each well. A well-known fungicide called voriconazole is used as the standard substance. Following 72 hours of culture at 25°C to 30°C, the zones of inhibition for each of these fungi around the growing culture plate wells were determined in millimeters (mm) [9].

3. Results and Discussion

Table-1 showed the results of antifungal activity of various plant fractions of *Pongamia pinnata* (L.) (Leaves), *Boerhavia erecta* (L.) (Whole plant), *Cayratia trifolia* (L.) (Whole plant), *Grewia hirsuta Vahl* (Leaves), *Convolvulus pentanthus (Jacq.) G. Don* (Whole plant) in different solvents fractions against different *Fusarium* species.

Table.1. Table-1 Antifungal activity of various plant fractions on different *Fusarium* species

Sr. No.	Name of the plant	Different solvent extract	Minimum inhibitory concentration (µg/ml)					
			Fusarium oxysporum	*Fusarium proliferatum*	*Fusarium pseudocircinatum*	*Fusarium graminearum,*	*Fusarium solani*	*Fusarium moniliformae*
1	*Pongamia pinnata* (L.)	Water	158	130	238	198	254	351
		Dimethyl formamide	263	141	257	178	230	331
		Ethanol	270	172	355	290	432	190
		Acetone	173	224	238	279	260	220
		Isopropanol	260	326	198	200	262	184
		Toluene	176	272	344	165	270	342
2	*Boerhavia erecta* (L.)	Water	248	180	163	192	168	188
		Dimethyl formamide	190	270	235	323	338	344
		Ethanol	244	239	253	368	222	298
		Acetone	180	164	148	320	374	381
		Isopropanol	288	343	261	166	178	320
		Toluene	220	198	174	316	260	328
3	Cayratia trifolia (L.)	Water	190	246	344	422	260	420
		Dimethyl formamide	310	278	268	162	183	189
		Ethanol	178	213	165	178	233	180
		Acetone	267	344	145	155	180	400
		Isopropanol	133	156	279	288	344	290
		Toluene	254	270	212	196	186	128
4	*Grewia hirsuta Vahl*	Water	190	154	132	182	344	210
		Dimethyl formamide	200	243	156	280	268	302
		Ethanol	266	269	234	366	170	322
		Acetone	160	159	322	350	366	368
		Isopropanol	219	322	366	289	182	148
		Toluene	142	158	320	368	450	233
5	*Convolvulus pentanthus (Jacq.) G. Don*	Water	223	152	194	266	320	200
		Dimethyl formamide	169	253	174	196	231	244
		Ethanol	142	239	191	322	368	329
		Acetone	233	256	146	192	220	310
		Isopropanol	139	292	182	278	174	190
		Toluene	182	290	180	156	170	344
6	Voriconazole	--	63	61	61	57	59	64

The water extract of *Boerhavia erecta* showed higher antifungal property with MIC (180 µg/ml) against *Fusarium proliferatum*, (163 µg/ml) against *Fusarium pseudocircinatum*, (192 µg/ml) against *Fusarium graminearum*, (168 µg/ml) against *Fusarium solani*, and (188 µg/ml) against *Fusarium moniliformae* and acetone extract *Boerhavia erecta* showed (180 µg/ml) against Fusarium *oxysporum*, (164 µg/ml) against *Fusarium proliferatum* and (148 µg/ml) against *Fusarium pseudocircinatum*. The isopropanol extract of *Boerhavia erecta* showed considerable antifungal property with MIC (166 µg/ml) against *Fusarium graminearum*, (178 µg/ml) against *Fusarium solani* and incase of toluene extract (198 µg/ml) against *Fusarium proliferatum*, (174 µg/ml) against *Fusarium pseudocircinatum*.

The water extract of *Pongamia pinnata* showed the antifungal property with MIC (158 µg/ml) against *Fusarium oxysporum*, (130 µg/ml) against *Fusarium proliferatum*, (198 µg/ml) against Fusarium *graminearum* and dimethyl formamide extract of *Pongamia pinnata* showed the antifungal property with MIC values (141 µg/ml) against *Fusarium proliferatum*, (178 µg/ml) against *Fusarium graminearum*. The ethanol extract of *Pongamia pinnata* showed the antifungal property with MIC values (172 µg/ml) against *Fusarium proliferatum*, and (190 µg/ml) against *Fusarium moniliformae*. The acetone extract of *Pongamia pinnata* showed the antifungal property with MIC values (173 µg/ml) against *Fusarium oxysporum*, isopropanol extract exhibited antifungal activity with MIC values (198 µg/ml) against *Fusarium pseudocircinatum*, (184 µg/ml) against *Fusarium moniliformae* and toluene extract showed antifungal activity with MIC (176 µg/ml) against *Fusarium oxysporum*, (165 µg/ml) against *Fusarium graminearum*.

The water extract of *Cayratia trifolia* showed the antifungal property with MIC values (190 µg/ml) against *Fusarium oxysporum*. In case of dimethyl formamide extract of *Cayratia trifolia* showed the antifungal property with MIC (162 µg/ml) against Fusarium *graminearum*, (183 µg/ml) against *Fusarium solani*, (189 µg/ml) against *Fusarium moniliformae*. The ethanol extract of *Cayratia trifolia* showed the antifungal property with MIC (178 µg/ml) against *Fusarium oxysporum*, (165 µg/ml) against *Fusarium pseudocircinatum*, (178 µg/ml) against *Fusarium graminearum*, and 180 µg/ml) against *Fusarium moniliformae*. The acetone extract showed antifungal activity with MIC values (145 µg/ml) against *Fusarium pseudocircinatum*, (155 µg/ml) against *Fusarium graminearum*, and 180 µg/ml) against *Fusarium solani*. The isopropanol extract *Cayratia trifolia* showed the antifungal property with MIC (133 µg/ml) against *Fusarium oxysporum*, (156 µg/ml) against *Fusarium proliferatum* and toluene extract showed antifungal activity with MIC values (196 µg/ml) against *Fusarium graminearum*, 186 µg/ml) against *Fusarium solani* and 128 µg/ml) against *Fusarium moniliformae*.

The water extract of *Grewia hirsuta* showed the antifungal property with MIC (190 µg/ml) against *Fusarium oxysporum*, (154 µg/ml) against *Fusarium proliferatum*, (132 µg/ml) against *Fusarium pseudocircinatum*, (182 µg/ml) against *Fusarium graminearum*, ethanol extract showed antifungal activity against 170 µg/ml) against *Fusarium solani*, acetone extract with MIC values (160 µg/ml) against *Fusarium oxysporum*, and toluene extract showed antifungal activity with MIC values (142 µg/ml) against *Fusarium oxysporum*, (158 µg/ml) against *Fusarium proliferatum*.

The water extract of *Convolvulus pentanthus* showed the antifungal property with MIC values (152 µg/ml) against *Fusarium proliferatum*, (194 µg/ml) against *Fusarium pseudocircinatum*. The dimethyl formamide extract of *Convolvulus pentanthus* showed the antifungal property with MIC values (169 µg/ml) against *Fusarium oxysporum*, (174 µg/ml) against *Fusarium pseudocircinatum*, (196 µg/ml) against *Fusarium graminearum*, the ethanol extract showed MIC values (142 µg/ml) against *Fusarium oxysporum*,, (191 µg/ml) against *Fusarium pseudocircinatum* and acetone extract showed antifungal activity against (146 µg/ml) against *Fusarium pseudocircinatum*, (192 µg/ml) against *Fusarium graminearum*. The isopropanol extract showed antifungal activity with MIC values (139 µg/ml) against *Fusarium oxysporum*, (182 µg/ml) against *Fusarium pseudocircinatum*, (174 µg/ml) against *Fusarium solani*, 190 µg/ml) against *Fusarium moniliformae.* The toluene extract of *Convolvulus pentanthus* showed the antifungal property with MIC values (182 µg/ml) against *Fusarium* *oxysporum*, (180 µg/ml) against *Fusarium pseudocircinatum*, (156 µg/ml) against *Fusarium graminearum* and (170 µg/ml) against *Fusarium solani*. The antifungal activity of various solvent extracts showed considerable MIC values and results were compared with Voriconazole as standard antifungal compound.

It was believed that assessing for the antifungal properties of nearby plants might prove helpful, especially the necessity for a more environmentally friendly method of managing the fungus. The results of this study show that plant based extract preparations have a variety of effects on the fungal hyphae development of different kinds of *Fusarium*, and there is a definite potential for a new, effective antifungal since several of the mentioned extracts significantly reduce the examined fungus's filaments multiplication. Among the chosen plants examined, the ethanol extract of *Cayratia trifolia* and the water fractions of *Grewia hirsuta* exhibited the strongest inhibitory effects. This could be because these plants extracts contained secondary chemical compounds that are antimicrobial, and it has many therapeutic benefits [10]. Therefore, spraying damaged plants with *Grewia hirsuta* water portions and *Cayratia trifolia* ethanol extract might give defense against harmful organisms like *Fusarium* species. Variety of phytochemical constitutes like polyphenolic substances are examples of compounds that are present in plant extracts and have a variety of medicinal properties [11].

The combination of these one or more fractions from plants may boost activity, according to many studies. This appears to be because combining two or more botanical compounds has been shown to have a cumulative effect on disease-causing plant pathogen. Numerous *Fusarium* species are out of control multiplications and are in the direct and indirect ways damaging vegetables, food grains, oil seed plants, and some fruit plants. Numerous biological controlling strategies exist, and a wide range of plant extract applications will provide an extensive framework for the organic efforts to prevent various plant diseases.

Conclusion

Grewia hirsuta (leaves) and *Cayratia trifolia* (whole plant) both have considerable antifungal properties. The substantial amount of phenolic chemicals in some plants may be the cause of their increased antifungal property in various solvent extracts. Further investigation is needed, to find and comprehend the composition of the bioactive ingredients in plant extracts that appears to be in responsible for the antifungal property of these selected medicinal plants,

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