Antifungal properties of Some Medicinal Plants Against *Fusarium* Species Useful in Improvements of Crop Health

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Abstract: **In order to avoid *Fusarium* infections in the various agricultural plants, the antifungal activities were investigated in the current study according to the agar diffusion technique. The plants that were chosen are *Dalbergia sissoo* (Roxb. ex DC.) (Leaves), *Cassia tora* (L.) (Leaves), *Cassia occidentalis* (L.) (Leaves), and *Solanum xanthocarpum* (L.) (Whole plant) and *Commelina benghalensis* (L.) (Whole plant). Toluene, isopropanol, acetone, ethanol, dimethyl formamide, and water were among the solvents used to extract the plant samples using a Soxhlet apparatus. These solvents were tested against several *Fusarium species*. The *Fusarium* fungus was significantly suppressed by the chosen plant extracts. Water, ethanol, acetone, dimethyl formamide isopropanol, and toluene of certain plant fractions were shown to significantly inhibit different species of *Fusarium*. *Fusarium oxysporum* (177 µg/ml), *Fusarium proliferatum* (129 µg/ml), *Fusarium pseudocircinatum* (185 µg/ml), *Fusarium graminearum* (204 µg/ml), and *Fusarium solani* (189 µg/ml) were all most inhibited by *Commelina benghalensis* (L.) water extract. *Dalbergia sissoo* (Roxb. ex DC.) ethanol fractions demonstrated notable efficacy against *Fusarium oxysporum* (170 µg/ml), *Fusarium proliferatum* (195 µg/ml), *Fusarium pseudocircinatum* (134 µg/ml), *Fusarium graminearum* (210 µg/ml), *Fusarium solani* (148 µg/ml), and *Fusarium moniliformae* (243 µg/ml). *Cassia tora* (L.) toluene extract had the lowest antifungal effectiveness against *Fusarium pseudocircinatum* (502 µg/ml) and *Fusarium graminearum* (468 µg/ml). The results of the current study were compared using voriconazole as a standard reference component.**

Keywords: *Fusarium* species, Antifungal properties, plant extracts, Agricultural crop plants

INTRODUCTION

Fungal infections are responsible for about 70% of plant illnesses that endanger food security. Furthermore, mycotoxins are produced by a variety of fungal infections, such as *Fusarium* spp., and provide an additional risk to the health of people and animals. In crop production, particularly in the production of cereals, *Fusarium* spp. are also crucial to food safety. Numerous agronomically significant plant infections, mycotoxin makers, and opportunistic human pathogens are found in the genus *Fusarium*, which is among the most commercially significant fungus (Tian et al., 2020). These mycotoxins are mostly produced in the field before to harvest by this vast and varied fungal family. Despite having a strong preference for temperate regions, *Fusarium* species may adapt to a wide range of environments and infect crops worldwide. Human or animal consumption of grain contaminated with mycotoxin may result in acute or chronic sickness and, in some situations, death. Trichothecenes, fumonisins, and zearalenone are the most common and hazardous *Fusarium* toxins that have significant commercial value. Numerous species of *Fusarium* may harm a number of significant crops such as tomato, ground nut, banana, wheat, corn, soybean, sunflower; two of them, *Fusarium graminearum* and *Fusarium oxysporum*, are included in the list of the top 10 fungal diseases in plant pathology. Root or stem rots, cankers, vascular wilts, fruit or seed rots, and leaf diseases are some of the potential disease signs brought on by *Fusarium* species. Numerous crops, including important food and cash crops like wheat, barley, maize, bananas, and cotton, are susceptible to a variety of plant diseases caused by the majority of *Fusarium* species, which can have a catastrophic socioeconomic effect (Dean et al., 2012). Despite being a significant source of food for both people and animals, fungal diseases often target cereal crops. These illnesses are very hard to manage, often sneak up on you, and don't show any signs at first (Burgess & Bryden, 2012). Their broad host ranges,

Fusarium infection, and diverse survival and dissemination strategies are all factors in their effectiveness as plant diseases. Representatives may be found in natural and agricultural environments in almost every bioclimatic area of the planet. Additionally, new fungal infections have the potential to endanger ecological settings and/or food production. Because fungi may readily overcome host resistance, it is difficult to successfully manage fungal illnesses (Rampersad, 2020). One such strategy that has a lot to offer in terms of raising agricultural output is the biological management of fungal infections.

MATERIALS AND METHODS

Plant material:

The plants *Solanum xanthocarpum* (L.) (Whole plant), *Commelina benghalensis* (L.) (Whole plant), *Cassia tora* (L.) (Leaves), *Cassia occidentalis* (L.) (Leaves), and *Dalbergia sissoo* (Roxb. ex DC.) (Leaves) were collected from the Bhokar area of the District of Nanded and identified and verified by a taxonomist from Yeshwant Mahavidyalaya, Nanded, Maharashtra-43102.

Plant extracts preparations:

Dalbergia sissoo (Roxb. ex DC.) (Leaves), *Cassia tora* (L.) (Leaves), *Cassia occidentalis* (L.) (Leaves), and *Solanum xanthocarpum* (L.) (Whole plant) were gathered and left to dry in the shade. After the plant parts had dried, they were then ground in a mixer grinder to a very fine powder. To extract the plants from the extremely fine powder, the Soxhlet apparatus was used in addition to a variety of solvents, including as water, dimethyl formamide, ethanol, acetone, isopropanol, and toluene. After completion of extraction, the concentrated sample was stored in the refrigerator for use in various types of investigations.

Test microorganisms:

The test organisms employed in the present investigation included *Fusarium oxysporum, Fusarium proliferatum, Fusarium pseudocircinatum, Fusarium graminearum, Fusarium solani,* and *Fusarium moniliformae*. Following their separation from field soil and decaying plant parts, they were identified by their form, color, hyphae, spores, and conidia. The fungal cultures were then regularly subcultured for the current antifungal investigation using selected plant extracts.

Antifungal activity by agar diffusion method:

The agar well diffusion method was used to examine the antifungal activity of a number of plant extracts. Several species of *Fusarium* fungus inoculums were uniformly distributed on the sterile petriplates using solidified potato dextrose agar medium. On each agar plate, three wells were made using a sterile cork borer. Each well received varying concentrations of different substances. The reference material is the common fungicide voriconazole. Following 72 hours of culture at 25°C to 30°C, the diameter (mm) of the zone of inhibition for each of these fungi was measured around the wells of the culture plates (Valenzuela-Cota et al., 2014).

RESULTS AND DISCUSSION

Table-1 showed the Profile of antifungal activity of various plant fractions *Solanum xanthocarpum* (L.), *Commelina benghalensis* (L.), *Cassia tora* (L.), *Cassia occidentalis* (L.), *Dalbergia sissoo* (Roxb. ex DC.) in different solvents fractions against different *Fusarium* species. The water extract of *Solanum xanthocarpum* exhibited higher antifungal property with MIC (189 µg/ml) against *Fusarium proliferatum*, (142 µg/ml) against *Fusarium graminearum*, and (128 µg/ml) against *Fusarium moniliformae* and dimethyl formamide extract *Solanum xanthocarpum* showed (120 µg/ml) against *Fusarium proliferatum*, (182 µg/ml) against *Fusarium pseudocircinatum*. (177 µg/ml) against *Fusarium graminearum*. The ethanol extract of *Solanum xanthocarpum* showed MIC (142 µg/ml) against *Fusarium proliferatum*, (127 µg/ml) against *Fusarium moniliformae*. The acetone fraction of *Solanum xanthocarpum* showed MIC (168 µg/ml) against *Fusarium oxysporum*, (132 µg/ml) against *Fusarium proliferatum*, (175 µg/ml) against *Fusarium graminearum*, and (127 µg/ml) against *Fusarium moniliformae*. The lowest antifungal activity observed in isopropanol fractions of *Solanum xanthocarpum* with MIC (486 µg/ml) against *Fusarium oxysporum*, (253 µg/ml) against *Fusarium proliferatum*, (260 µg/ml) against *Fusarium pseudocircinatum*, (326 µg/ml) against *Fusarium graminearum*, (292 µg/ml) against *Fusarium solani*, and (402 µg/ml) against *Fusarium moniliformae.* The water fraction of *Commelina benghalensis* (L.) showed MIC (177

µg/ml) against *Fusarium oxysporum*, (129 µg/ml) against *Fusarium proliferatum*, (185 µg/ml) against *Fusarium pseudocircinatum*, (204 µg/ml) against *Fusarium graminearum*, (189 µg/ml) against *Fusarium solani*, and (270 µg/ml) against *Fusarium moniliformae.* The dimethyl formamide fraction of *Commelina benghalensis* (L.) showed MIC (162 µg/ml) against *Fusarium oxysporum*, (245 µg/ml) against *Fusarium proliferatum*, (352 µg/ml) against *Fusarium pseudocircinatum*, (322 µg/ml) against *Fusarium graminearum*, (146 µg/ml) against *Fusarium solani*, and (172 µg/ml) against *Fusarium moniliformae.* The ethanol fraction of *Commelina benghalensis* (L.) showed substantial MIC (172 µg/ml) against *Fusarium pseudocircinatum*. The acetone fraction of *Commelina benghalensis* (L.) showed moderate antifungal activity with MIC (180 µg/ml) against *Fusarium oxysporum*, (230 µg/ml) against *Fusarium proliferatum*, (244 µg/ml) against *Fusarium pseudocircinatum*, (198 µg/ml) against *Fusarium graminearum*, (123 µg/ml) against *Fusarium solani*, and (204 µg/ml) against *Fusarium moniliformae.* The ethanol fraction of *Cassia tora* (L.) showed significant MIC (168 µg/ml) against *Fusarium pseudocircinatum* and toluene fraction showed significant MIC (142 µg/ml) against *Fusarium oxysporum*. The water fraction of *Cassia occidentalis* (L.) showed considerable MIC (146 µg/ml) against *Fusarium oxysporum*, (188 µg/ml) against *Fusarium proliferatum*, (260 µg/ml) against *Fusarium pseudocircinatum*, (167 µg/ml) against *Fusarium graminearum*, (438 µg/ml) against *Fusarium solani*, and (122 µg/ml) against *Fusarium moniliformae.*

The ethanol fraction of *Cassia occidentalis* (L.) showed moderate MIC (170 µg/ml) against *Fusarium oxysporum*, (195 µg/ml) against *Fusarium proliferatum*, (134 µg/ml) against *Fusarium pseudocircinatum*, (210 µg/ml) against *Fusarium graminearum*, (148 µg/ml) against *Fusarium solani*, and (243 µg/ml) against *Fusarium moniliformae.* The obtained MIC values were compared with known antifungal agent voriconazole with MIC (64 µg/ml) against *Fusarium oxysporum*, (63 µg/ml) against *Fusarium proliferatum*, (62 µg/ml) against *Fusarium pseudocircinatum*, (59 µg/ml) against *Fusarium graminearum*, (60 µg/ml) against *Fusarium solani*, and (65 µg/ml) against *Fusarium moniliformae.*

Assessing the antifungal properties of easily accessible beneficial plants was thought to be useful, given the need for a more ecologically friendly approach to phytopathogen management. The findings of this investigation demonstrate that plant preparations have a range of impacts on *Fusarium* species' colony growth, and because some of these extracts greatly limit the experimental fungus's colony expansion, there is a clear possibility for a novel, strong fungicide. Of the plants that were analyzed, the components of *Solanum xanthocarpum* and *Commelina benghalensis* exhibited the strongest inhibitory effects on several *Fusarium* species. This may be due to the presence of secondary metabolites in the plant samples that have antifungal properties and a range of therapeutic applications (Elamin, 2016). In order to protect ill plants from dangerous infections like *Fusarium* species, *Cassia occidentalis*, *Cassia tora* and *Dalbergia sissoo* may be used to treat them with different solvent components. Phytochemicals with a range of therapeutic uses, such as alkaloids, saponins, coumarins, polyphenols, terpenoids and glycosides, are found in plant extracts (Dweba et al., 2017). According to several deep researches, combining these two or more plant extracts combinations may increase activity. It has been shown that mixing several phytochemicals has a synergistic impact on pathogenic organisms, which may explain this. Unchecked *Fusarium* species are causing direct and indirect harm to oil seed plants, vegetables, cereal crops, and some fruit plants. Numerous bio-control techniques are available, and a broad variety of uses for plant extracts will provide a significant platform for the biological management using mixer of plant extracts against the different plant diseases (Elamin, 2016).

Although synthetic fungicides have shown promising results in reducing *Fusarium*, safer management techniques are desperately needed for the sake of the environment and future generations. Accordingly, the use of phytochemicals and plant bioactive compounds may provide a viable substitute for synthetic fungicides. Simple polyphenols, phenolic acids, complex tannins, terpenoids, constitute the most varied category of plant secondary metabolites known as phenolic chemicals, which have been shown to be effective defenses against plant diseases. Their primary benefit is that they are harmless for the environment since they biodegrade readily (Cowan 1999).

CONCLUSION

Selected plants are suggested as a great and natural fungus management solution, and they may be developed as a substitute for synthetic fungicides to lower the risk of *Fusarium* infection. However, when tested against several *Fusarium* species, extracts of *Solanum xanthocarpum*, *Cassia Occidentalis*, *Dalbergia sissoo*, and *Commelina benghalensis* were shown to have inhibitory activity in a variety of solvent extracts. As a result, further research is required on solvent selection, dosages, pharmacological components, different ways of activity, and applications.

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Table-1 Profile of antifungal activity of various plant fractions

Sr. No.	Name of the plant	Different solvent fractions	Minimum inhibitory concentration (µg/ml)					
			Fusarium oxysporum	*Fusarium proliferatum*	*Fusarium pseudocircinatum*	*Fusarium graminearum*	*Fusariu m solani*	*Fusarium moniliformae*
1	*Solanum xanthocarp um* (L.)	Water	231	189	244	142	238	128
		Dimethyl formamide	330	120	182	177	423	290
		Ethanol	233	142	266	281	268	127
		Acetone	168	132	310	175	230	153
		Isopropanol	486	253	260	326	292	402
		Toluene	367	237	163	264	322	200
2	*Commelina benghalens is* (L.)	Water	177	129	185	204	189	270
		Dimethyl formamide	162	243	352	322	146	172
		Ethanol	266	349	172	400	371	190

		Acetone	180	230	244	198	123	204
		Isopropanol	340	255	290	266	322	273
		Toluene	386	176	377	390	404	199
3	*Cassia tora* (L.)	Water	253	388	240	190	233	155
		Dimethyl formamide	231	243	154	180	364	234
		Ethanol	290	254	168	368	351	156
		Acetone	244	239	374	322	190	244
		Isopropanol	302	200	299	466	372	187
		Toluene	142	238	502	468	322	213
4	*Cassia occidentalis* (L.)	Water	146	188	260	167	438	122
		Dimethyl formamide	264	168	246	302	313	235
		Ethanol	278	300	366	252	288	244
		Acetone	168	180	320	168	163	192
		Isopropanol	344	210	440	178	180	200
		Toluene	450	322	170	245	300	349
5	*Dalbergia sissoo* (Roxb. ex DC.)	Water	244	466	352	380	139	175
		Dimethyl formamide	203	190	260	272	200	188
		Ethanol	170	195	134	210	148	243
		Acetone	156	130	364	293	211	160
		Isopropanol	245	340	278	266	389	190
		Toluene	302	256	382	340	174	258
6	Voriconazole	--	64	63	62	59	60	65