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Biological Efficacy of Wild Medicinal Plants against Three Fungal Fruit Diseases Occurring in District Bhimber Azad Jammu and Kashmir, Pakistan

Tanveer Hussain[1], Muhammad Ishttiaq[1]*, Saba Ashraf[1], Mehwish Maqbool[1], Faheem Ahmed Khan[2] and Waheeda Mushtaq[1] and Abdul Ghani[3]

[1]Department of Botany, Mirpur University of Science and Technology (MUST) Mirpur- 10250 (AJ&K), **Pakistan**
[2]Department of Biotechnology and Microbiology, Abasyn University Peshawar, **Pakistan**
[3]Department of Botany, Sargodha University Sargodha, **Pakistan**

***Correspondence:** drishtaiq.bot@must.edu.pk **Received 16-02-2021, Revised: 26-03-2021, Accepted: 01-04-2021 e-Published: 10-04-2021**

The present study deals with the efficacy of biological extracts of wild medicinal plants (WMPs) against some fungal pathogens attacking on edible fruits in District Bhimber, Azad Jammu and Kashmir (AJK), Pakistan. In this research, four WMPs named as; *Butea monosperma* (Lam.) Taub*, Acacia modesta* Wall.*, Ziziphus mauritiana* (L.) Lam. and *Morus alba* L. extracts were applied against *Aspergillus niger* (which causes black mold)*, Botrytis cinerea* (causes grey mould) and *Aspergillus ibericus* (causes rot disease). The in-vitro antifungal effects of the MPs were measured by Agar Well Diffusion Method (AWDM) that showed positive results against the dominant fruit fungal pathogens (FFPs). It was observed that methanolic extract of selected MPs indicated maximum antifungal activity against dominant isolated FFP as compared to other three suspensions. Among the selected four MPs, *Butea monosperma* was observed more effective against FFP than *Acacia modesta, Ziziphus mauritiana* and *Morus alba*. It was assessed that *Butea monosperma* extracts contained more antifungal secondary metabolites comparatively to *Morus alba, Acacia modesta,* and *Ziziphus mauritiana.* It was also observed that methanolic extract of *Butea monosperma* showed highest growth rate (8.50 ± 0.29) against isolated fungal pathogens as compare to ethyl ether, chloroform and distilled water extracts. Distilled water extracts of selected medicinal plants exhibited lowest growth rate (1.00 ± 0.29) against fungal pathogens. Hence, it was concluded that selected WMPs are very effective, safe and have good eradication potential against the selected FFP of the study area. *Butea monosperma* MP was *recommended* for future antifungal secondary metabolites/compound analysis through ethnopharmacological and pharmaceutical analysis to explore and prepare green and environment friendly antimycopathogens.

Keywords: Fungal pathogens; *Butea monosperma;* Medicinal plants; Fruit plants; Antifungal analysis; Bhimber; Azad Jammu and Kashmir

INTRODUCTION

Fungi have a vital role in the microbiological world. Three kinds of fungi (Yeasts, Moulds and Mushrooms) are more important because they use for the preparation of certain different types of foods as making cheese, bread and liquors. Some antibiotics and anti-fungal drugs were also prepared by the use of these fungal species. Mushrooms are good source of protein and boost up immunity level in organisms (Mohmand et al.

2011). Fungi play important role in biotechnology, genetic engineering, pollution control and also in biological control of pests (Molitoris et al. 1995). Secondary metabolites of fungi which were isolated from leaves of bush mango had antimicrobial activity against some selected microorganisms like *Staphylococcus aureus, Pseudomonas aeruginosa, Escherichia coli, Bacillus subtilis, Penicillium chrysogenum and Aspergillus fumigatus*. Each secondary metabolite showed antimicrobial activity against selected microorganisms or its infections (Nwakanma et al. 2016).

Fruits were contaminated by different types of microorganism's especially fungal pathogens. Many fungal pathogens were isolated from spoilage of fruits. Different fungal pathogens were isolated from contaminated fruits such as *Aspergillus flavus, Aspergillus fumigatus, Aspergillus niger, Rhizopus stolonifer, Mucor mucedo and Alternaria* species *Aspergillus niger* was the most common fungal pathogen found in fruit plants (Mukhtar et al. 2019).

All plants are beneficial but some plants are the common sources of medicine. In early systems of medicine such as Unani, Ayurveda and Chinese traditional medicine support herbs that were used for the treatment of diseases and also for stimulating body systems. Some medicinal plant extracts were used as antifungal, antibacterial and antioxidant due to presence of some chemical compounds (Aslam et al. 2016). In many developing countries medicinal plants have been used as a source of medicine. For thousands of years' medicinal plants have been used for conservation of food, production of medicines and also used in treatment of health disorders. On the basis of antimicrobial activity medicinal plants were used as resistant to pathogenic microorganisms (Singh et al. 2015).

Medicinal plant extracts were used against many fungal pathogens. By agar well diffusion method antifungal activities of five different medicinal plants namely, *Mimosa pudica* L., *Lawsonia inermis* L., *Tephrosia purpurea Pens, Phyllanthus niruri* L. *and Vinca rosea* L. were checked against plant pathogenic fungi *Pythium debaryanum*. *Pythium debaryanum* pathogen causes damping off of disease in many plants. Extracts of plants leaves with different solvents methanol, aqueous and n-butanol were used against fungal pathogen (Mahalingam et al. 2011). Some fruits are very liable to attack by pathogenic fungi due to their low pH, nutritional composition and higher moisture content. Some fungi make fruits unfit for eating by producing mycotoxins and also produce fruit rots (Chen et al. 2020). *Fusarium oxysporum* was a fruit spoilage fungus detected from banana and grape. *Aspergillus japonicus* isolated from Fig and apricot. *Aspergillus oryzae* isolated and identified from orange. *Aspergillus awamori* was identified from lemon. *Aspergillus phoenicis and Aspergillus tubingensis* were isolated from tomato and peach, respectively. *Aspergillus niger, Aspergillus foetidus, Rhizopus stolonifer and Aspergillus flavus* were isolated and identified from apple, kiwi, date palm and mango fruit plants respectively (Parida et al. 2020).

Ziziphus mauritiana is a fruit tree which has nutritional as well as medicinal values. Different solvents extracts of *Ziziphus mauritiana* leaves have antimicrobial, antioxidant, anticancer and antitumor activities due to presence of different chemical composition. In pharmaceutical industries *Ziziphus mauritiana* leaves extracts with effective biological activities used as antitumor, anticancer, antioxidant and antifungal agents*. Z. mauritiana* is also used as component for the improvement of natural drugs (Ashraf et al. 2015). Mulberry is widely cultivated in Maharashtra. *Morus alba* has medicinal properties like anti-diabetic, anti-oxidant, lipid lowering, anticancer and antimicrobial (Akshata *et* al. 2018). Different solvent extracts of *Butea monosperma* possess important antifungal, antidiabetic, anti-asthmatic, antibacterial and anti-inflammatory properties (Fageria et al. 2015). *Acacia modesta* has been used to treat wounds, leprosy, venereal diseases, body weakness, cough, dysentery and bacterial infections. At present, use of herbal and natural medicines is more effective and no side effect as compare to synthetic medicines (Sarwar et al. 2016).

Many medicinal plants were used as antimicrobial, antifungal and anti- oxidant. *Acacia nilotica* used as antimicrobial, antifungal and anti-oxidant plant. Different extracts of acacia nilotica were used against fungal pathogens *Penicillium italicum* and *Aspergillus niger*.by agar well diffusion method inhibition zone and radial growth were checked. Different solvent extracts were used and showed different affects. Bark and pods of tree are best effective and showed great antifungal activity (Abdel-Rahim et al. 2012).

Medicinal plant extracts were used against many fungal pathogens. By agar well diffusion method antifungal activities of five different medicinal plants namely, *Mimosa pudica* L., *Lawsonia inermis* L., *Tephrosia purpurea* Pens.

Phyllanthus niruri L. and *Vinca rosea* L. were checked against plant pathogenic fungi *Pythium debaryanum*. *Pythium debaryanum* pathogen which causes damping off disease on many fruit plants. Extracts of plants leaves with different solvents methanol, aqueous and n-butanol were used against fungal pathogen (Ambikapathy et al. 2011). Secondary metabolites of fungi which were isolated from leaves of bush mango had antimicrobial activity against some selected microorganisms like *Staphylococcus aureus, Pseudomonas aeruginosa, Escherichia coli, Bacillus subtilis, Penicillium chrysogenum and Aspergillus fumigates*. Each secondary metabolite showed antimicrobial activity against selected microorganisms or its infections (Nwakanma et al. 2016).

The methanolic leaf extracts of *Morus alba* was the most effective against the two fungus Aspergillus and Penicillium species. These both extracts of *Morus alba* had showed antimicrobial as well as antifungal activities (Niratker et al. 2015). All plants are beneficial but some plants are the common sources of medicine. Some medicinal plant extracts were used as antifungal, antibacterial and antioxidant due to presence of some chemical compounds (Aslam et al. 2016). However, lot of medicinal plants potential for the management of microbial diseases were still unexplored. Botanists are trying to elaborate the potential of different medicinal plants.

Therefore, the study was designed to detect the fungal pathogens present on local fruit plants grown in District Bhimber, Azad Jammu and Kashmir (AJ&K). To select local medicinal plants for in-vitro antifungal activity against isolated dominant fungal pathogens present on fruit trees like citrus, guava, papaya and grapes. To control fungal pathogens that attack on different fruit plants through the selected medicinal plants extract treatment under lab conditions. To recommend best management treatments or MPs for fungal pathogens of fruit plants.

MATERIALS AND METHODS

Sample collection:

Samples of effected leaves of fruit plants like *Vitis vinifera, Psidium guajava*, *Citrus limon*, *Mangifera indica* and *Carica papaya* with fungal pathogens were collected from study area and fresh leaves of selected medicinal plants like *Butea monosperma, Acacia modesta, Ziziphus mauritiana* and *Morus alba* were collected from different sites District Bhimber, AJ&K for antifungal activity. The trees from where the samples were collected must be tagged clearly (Loustau et al. 2018). The leaves were strip off from the stem, packed in a well perforated bag and then brought to laboratory. These fresh leaves were grounded with the help of pestle and mortar.After grinding the material extracts prepared in four chemicals separately (Tavhare and Nishteswar, 2014).

Methods for fungal isolation:

Leaves of fruit plants with infected parts were collected and cut them into small pieces with the help of blade. These pieces were washed in sterile water and fungi were isolated from plant tissue which showed clear symptoms. By using flame sterilized forceps, infected tissues were cut into small pieces and transferred into sterile petri dishes containing 0.1% sodium hypo chloride solution for 5-7 minutes which used as surface sterilizer of the plant tissues. After that the sterilized plant parts were shifted on potato dextrose agar (PDA) media plates. For complete growth of fungi, PDA plates with infected plant tissue were incubated for 5-7 days in growth chamber. After incubation periods, slides were prepared from fungal colonies for identification. The slides were identified by help of microscope and mycological literature (Al-Hindi et al. 2011).

Preparation of medicinal plants extracts in Distilled Water:

The selected medicinal plants were collected and brought to the laboratory. To remove dust particles and debris plant leaves were washed carefully with water. These are then rinsed in distilled water and weighed (25gms). Plants were ground in a sterile mortar. The resulting paste was added to 25 ml of sterile distilled water in 50 ml beaker, stirred strongly and allowed to stand for 1 hour and then filtered through sterile cotton cloth to obtain water extract (Raji et al. 2013).

Extract preparation in Methanol:

The selected medicinal plants were collected and brought to the laboratory. To remove dust particles and debris plant leaves were washed carefully with water. These are then rinsed in distilled water and weighed (25gms). Plants were ground in a sterile mortar. The resulting paste was added to 25 ml of methanol solution in 50 ml beaker, stirred strongly and allowed to stand for 1 hour and then filtered through sterile cotton cloth to obtain methanol extract (Raji et al.2013).

Extract preparation in Ethyl Ether:

The selected medicinal plants were collected and brought to the laboratory. To remove dust particles and debris plant leaves were washed carefully with water. These are then rinsed in distilled water and weighed (25gms). Plants were ground in a sterile mortar. The resulting paste was added to 25 ml of ethyl ether in 50 ml beaker, stirred vigorously and allowed to stand for 1 hour and then filtered through sterile cotton cloth to obtain ethyl ether extract (Raji et al. 2013; Ishtiaq et al. 2007).

Extract preparation in Chloroform:

The selected medicinal plants were collected and brought to the laboratory. To remove dust particles and debris plant leaves were washed carefully with water. These are then rinsed in distilled water and weighed (25gms). Plants were ground in a sterile mortar. The resulting paste was added to 25 ml of chloroform solution in 50 ml beaker, stirred strongly and allowed to stand for 1 hour and then filtered through sterile cotton cloth to obtain chloroform extract (Raji et al. 2013).

Identification of fungal isolates:

On the bases of micro-morphological and micro-morphological characteristics fungal isolates were identified. The morphological characteristics which contain growth of colony and colour, appearance and non-appearance of aerial mycelium, presence or absence of pigmentation, wrinkles and furrows between others were detected under the microscope and recorded. In all cases, sterile wire loop used to pick the mycelium from the mold culture. A drop of lactophenol blue was used for staining. The mycelium was then spread on the slide and covered with cover slip and observed under microscope under ×40 magnification lens. Fungal pathogens were identified and structure bearing spores (Oviasogie et al. 2015).

Sub-culturing of fungal species:

By using already autoclaved PDA medium in aseptic condition all strains were sub-cultured under laminar flow hood. One strain of *Aspergillus niger* and one strain of *Aspergillus ibericus* were sub-cultured from the isolated fungal colonies. Then these fungal strains incubated at room temperature for three to seven days in growth chamber. After the incubation period suspension of these fungal species were prepared for further experimental trials (Hu et al. 2011).

Agar Well Diffusion Method:

To found the antimicrobial activity of plant extracts agar well diffusion method was mostly used. Firstly, spreading the volume of microbial suspension over the entire agar surface and then a hole is punched with a sterile cork-borer. About 10 mL volume of plant extract solution is introduced into the well. Then, under suitable condition depending upon the test microorganism agar plates are incubated. The antimicrobial extract spreads in the agar medium and prevents the growth of the microbial strain tested (Balouiri et al. 2015).

RESULTS

The current study was conducted from December 2019 to July 2020 in Mirpur University of Science and Technology (MUST), Department of Botany, Bhimber Campus, Azad Jammu and Kashmir, Pakistan. This study is based on the antifungal activities of some selected medicinal plants against foliar diseases caused by fungi on fruit plants in District Bhimber, AJ&K, and Pakistan. Different fungal pathogens were isolated from effected leaves of fruit plants from the study area. Then the selected four medicinal plants extracts were assessed for antifungal activities against fungal pathogens.

Fungal species isolated from selected fruit plants:

In recent study, eight fungal species were detected from selected fruit plants named as; *Aspergillus niger, Penicillium expansum, Botrytis cinerea, Aspergillus ibericus, Rhizopus stolonifer, Botryodiplodia theobromae, Pestalotiopsis mangiferae* and *Mycosphaerella citri.*

Table 1: List of Fungal species Isolated from Selected Fruit plants of local markets of Samahni, AJK

S. NO	Name of fungal species	Name of plant source	Status
1	*Aspergillus niger*	Guava	Pathogenic
2	*Penicillium expansum*	Grapes	Pathogenic
3	*Botrytis cinerea*	Guava	Pathogenic
4	*Aspergillus ibericus*	Guava	Pathogenic
5	*Rhizopus stolonifer*	Grapes	Pathogenic
6	*Botryodiplodia theobromae*	Mango	Pathogenic
7	*Pestalotiopsis mangiferae*	Mango	Pathogenic
8	*Mycosphaerella citri*	Citrus	Pathogenic

Figure1: Effected leaves of Citrus with fungus from Samahni area of District Bhimber of AJK, Pakistan

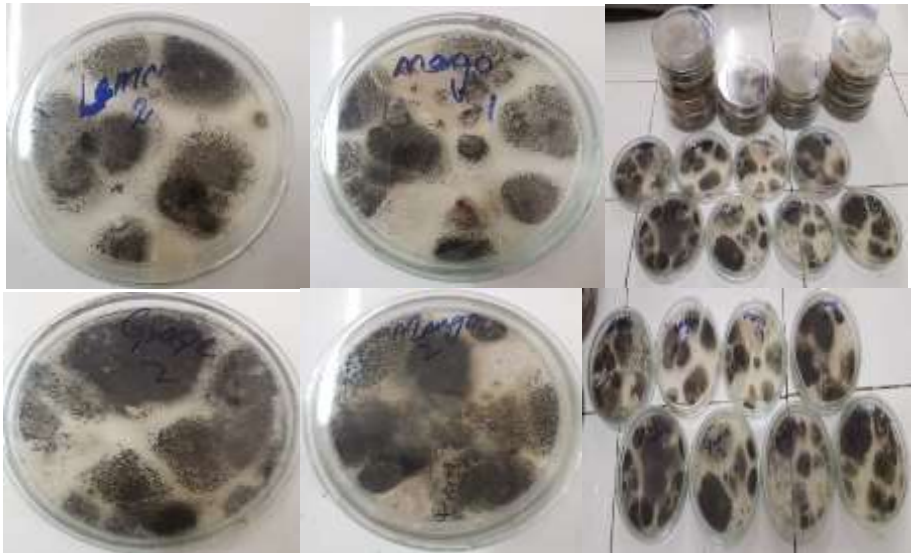

Figure 2: Petri plates showing Fungal pathogens isolated from fruit leaves from Samahni area of District Bhimber of AJK, Pakistan

All these fungal species which were isolated from leaves of some selected fruit plants are pathogenic in nature (Table 1).

In current study, the effect of medicinal plant *Acacia modesta*, *Ziziphus mauritiana, Morus alba* and *Butea monosperma* extracted in methanol, ethyl ether, chloroform and distilled water were measured against three selected fungal species.

Effects of *Acacia modesta* extracts on radial growth of pathogens:

Extracts of *Ziziphus mauritiana* in four different chemicals; were tested against three fungal pathogens. It was observed that methanol extract of *Acacia modesta* indicated higher growth rate 4.00 ± 0.57 against *Aspergillus ibericus* and lower growth rate 3.17 ± 0.44 against *Aspergillus niger*. Distilled water extract of selected medicinal plant also indicated higher growth rate 2.50 ± 0.28 against *Aspergillus ibericus* and showed lower growth rate 1.500±0.289 against *Aspergillus ibericus*. Current study showed that methanol extract of selected medicinal plant expressed maximum antifungal activity against selected fungal pathogens as compared to other three solvent extracts (Table 2).

Effect of *Ziziphus mauritiana* against fungal pathogens:

Responses of *Ziziphus mauritiana* in four different chemicals were analysed against selected three dominant fungal pathogens of fruit plants. Current study showed that methanol extract of selected medicinal plant shows maximum antifungal activity against selected isolated fungal pathogens as compared to other three solvent extracts of selected medicinal plant. Table 3 showed that methanol extract of *Ziziphus mauritiana* higher growth rate 4.00±0.58 against *Aspergillus niger* and lower growth rate 3.00 ± 0.58 against *Botrytis cinerea*. Distilled water extract occupied 2nd number in the invitro antifungal activity as; the selected medicinal plant showed higher growth rate 1.50 ± 0.29 against *Botrytis cinerea* and lower growth rate 1.00 ± 0.29 against *Aspergillus ibericus***.**

Table 2: Antifungal effect of *Acacia modesta* extracts against selected fruit plants fungal pathogens from Samahni area of District Bhimber of AJK, Pakistan

S. No	Fungal pathogens	Measurement of radial growth (ZI)			
		Distilled Water	Methanol	Ethyl ether	Chloroform
1	*Aspergillus niger*	1.00 ± 0.29	3.17 ± 0.44	1.50 ± 0.29	1.17 ± 0.44
2	*Botrytis cinerea*	0.77 ± 0.15	3.83 ± 0.44	2.00 ± 0.58	1.0 ± 0.29
3	*Aspergillus ibericus*	1.00 ± 0.29	4.00 ± 0.57	2.50 ± 0.29	1.50 ± 0.29
4	Control (antibiotic)	0.75 ± 0.14	2.19 ± 0.31	1.00 ± 0.21	0.50 ± 0.13

Table 3: Effect of *Ziziphus mauritiana* plant extracts against isolated fungal pathogens from fruit plants from Samahni area of District Bhimber of AJK, Pakistan

Sr. No	Names of pathogens	Measurement of zone of inhibition			
		Distilled Water	Methanol	Ethyl ether	Chloroform
1	*Aspergillus niger*	1.500±0.289	3.000± 0.577	2.833±0.441	1.833±0.441
2	*Botrytis cinerea*	1.000±0.289	4.000±0.577	3.833±0.441	2.333±0.441
3	*Aspergillus ibericus*	1.167±0.441	3.167±0.441	2.500±0.289	1.500±0.289

Table 4: Antifungal impact of *Morus alba* plant extract against isolated fungal pathogens from fruit trees from Samahni area of District Bhimber of AJK, Pakistan

Sr. No	Fungal pathogens	Measurement of zone of inhibition			
		Distilled Water	Methanol	Ethyl ether	Chloroform
1	*Aspergillus niger*	1.33 ± 0.44	4.50 ± 0.29	3.00 ± 0.29	2.83 ± 0.60
2	*Botrytis cinerea*	1.00 ± 0.29	4.00 ± 0.29	2.50 ± 0.29	1.67 ± 0.44
3	*Aspergillus ibericus*	2.00 ± 0.31	6.00 ± 0.58	4.00 ± 0.57	3.50 ± 0.289

Table 5: Antifungal effect of *Butea monosperma* plant extract against isolated fungal pathogens from Samahni area of District Bhimber of AJK, Pakistan

Sr. No	Names of pathogens	Measurement of zone of inhibition			
		Distilled Water	Methanol	Ethyl ether	Chloroform
1	*Aspergillus niger*	1.00 ± 0.29	8.50 ± 0.29	2.17 ± 0.61	1.17 ± 0.44
2	*Botrytis cinerea*	3.00 ± 0.29	7.17 ± 0.44	6.00 ± 0.58	4.00 ± 0.29
3	*Aspergillus ibericus*	1.0 ± 0.29	6.00 ± 0.58	4.00 ± 0.58	1.17 ± 0.29

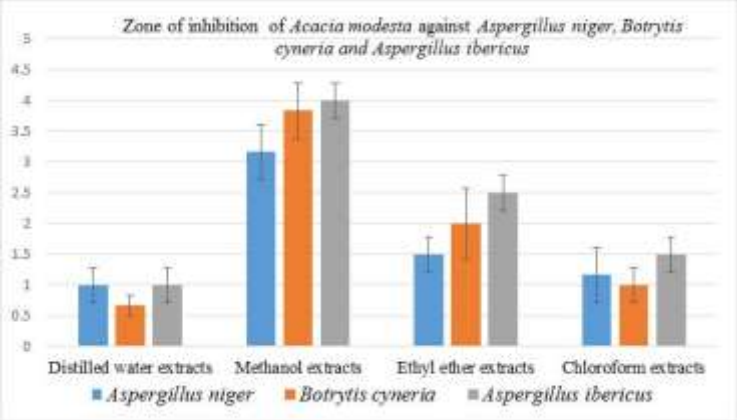

Figure 3: Zone of inhibition of *Acacia modesta* against *Aspergillus niger, Botrytis cyneria and Aspergillus ibericus* from Samahni area of District Bhimber of AJK, Pakistan

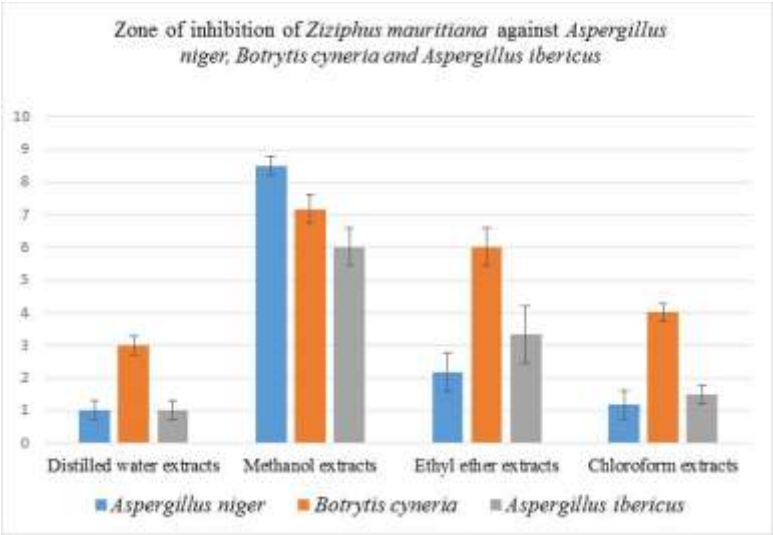

Figure 4: Zone of inhibition of *Ziziphus mauritiana* against *Aspergillus niger, Botrytis cyneria and Aspergillus ibericus* from Samahni area of District Bhimber of AJK, Pakistan

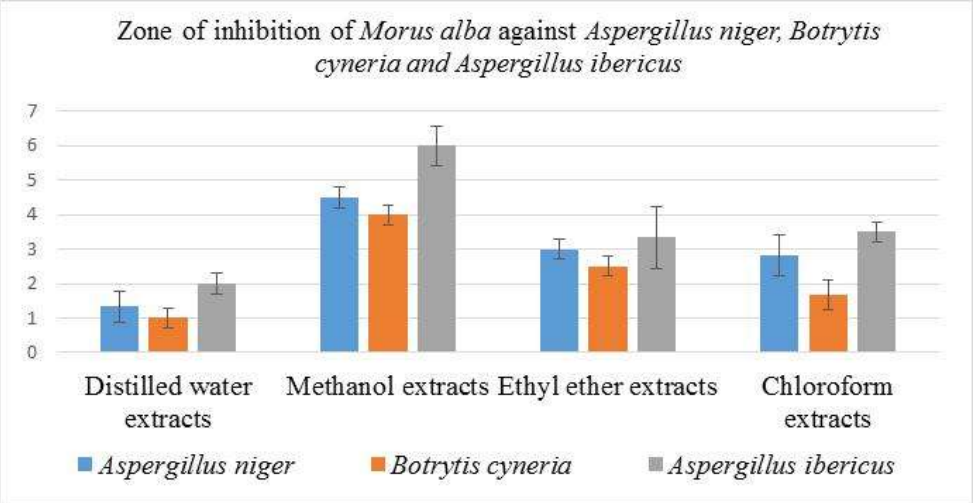

Figure 5: Zone of inhibition of *Morus alba* against *Aspergillus niger, Botrytis cyneria and Aspergillus ibericus* from Samahni area of District Bhimber of AJK, Pakistan

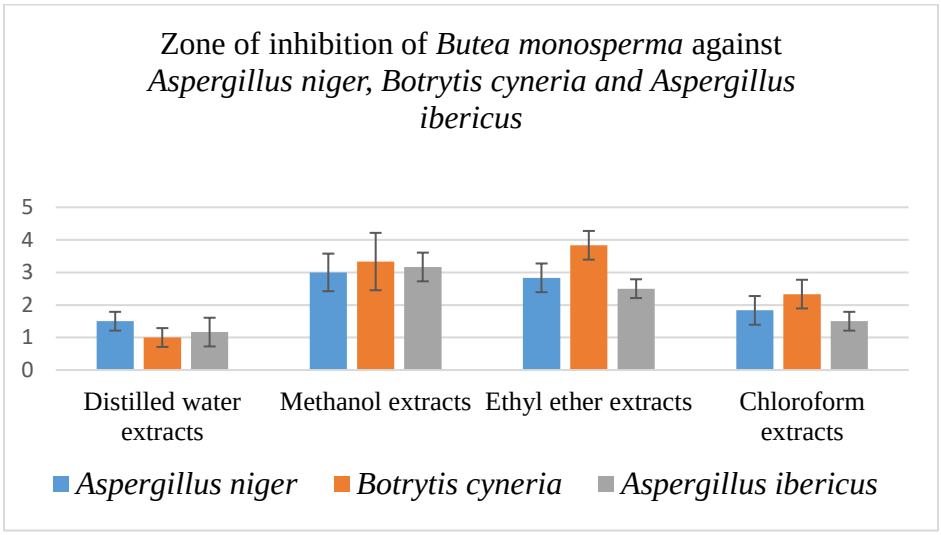

Figure 6: Zone of inhibition of Butea monosperma against *Aspergillus niger, Botrytis cyneria* and *Aspergillus ibericus* from Samahni area of District Bhimber of AJK, Pakistan

Impact of *Morus alba* against fungal pathogens:

Impact of *Morus alba was* also expressed positive correlation against selected three FFP in four different chemicals compounds. Current research highlighted that methanol extract of selected medicinal plant showed maximum antifungal activity against selected isolated fungal pathogens as compared to other three solvent extracts of selected medicinal plant (Table 4). It was investigated that methanol extract of *Morus alba* showed higher growth rate 6.00 ± 0.58 against *Aspergillus ibericus* while lower growth rate 4.50 ± 0.29 against *Aspergillus niger*. On the other hand, distilled water extract of selected medicinal plants indicated higher growth rate 4.00 ± 0.58 against *Aspergillus ibericus* and lower growth rate 2.50 ± 0.29 against *Botrytis cinerea.*

Responses of *Butea monosperma* against fungal pathogens:

Responses of *Butea monosperma* was maximum in four different chemicals compounds

against FFP as comparison to other three MPs.

The methanol extract of *Butea monosperma* expressed highest growth rate 8.00 ± 0.29 against *Aspergillus niger* while less growth rate 6.00 ± 0.58 against *Aspergillus ibericus*. Distilled water extract of selected medicinal plant showed higher growth rate 6.00 ± 0.58 against *Botrytis cinerea* and lower growth rate 2.17 ± 0.61 against *Aspergillus niger.*

DISCUSSION

The current study was explored the antifungal responses of medicinal plants named as; *Morus alba, Acacia modesta, Ziziphus mauritiana and Butea monosperma.* These medicinal plants have good potential for the declining the fruit related disease severity significantly. To test antifungal activity different four solvent used for medicinal plant extracts preparation. Similar study was conducted by Aslam et al. (2016). These scientists described that many plants are good source of medicines. They also used some medicinal plant extracts for antifungal activity that have different chemical compounds. These compounds may be having potential to control fungal diseases of plants.

Present study shows that extract of *Morus alba* in four different chemicals; in methanol, ethyl ether, chloroform and distilled water were used against three dominant fungal pathogens. Methanolic extract of *Morus alba* show highest antifungal activity as compare to other three solvents. Methanolic extract of selected medicinal plant expressed highest growth rate against *Aspergillus ibericus* and shows lowest growth rate against other two isolated fungal pathogens. While aqueous extract of selected medicinal plant shows lowest growth rate against *Botrytis cinerea.* These research findings were supported my results (Niratker et al. 2015), who also observed that methanolic leaf extract of *Morus alba* was the most effective against the two fungus *Aspergillus* and *Penicillium* species with largest diameter of zone of inhibition 30 mm and 20 mm, respectively while ethanolic extract showed the smallest zone of inhibition with 20 mm against the two fungal colonies. The result is in contract with the report of Mayuri et al. (2015), who also describe that the antifungal activity of extracts of two plant species used in traditional herbal medicine. On the bases of medicinal uses plants were selected. Water and Acetone extracts of two selected medicinal plant species were used for their antifungal activity against fungal pathogens "*Aspergillus niger"*. Higher antifungal activities have been determined from these extracts.

Responses of *Acacia modesta* extracts in four different chemicals against three FFP have positive antifungal activity. These findings indicated better medicinal potency of *A. modesta* plant. Bashir et al. *(*2011) reported similar discussion as determine the antifungal effect of 13 species of medicinal plants against apple grey mold. These medicinal plants inhibited the growth of fungal pathogens "*Botrytis cinerea*". Their findings also elaborated that with rising of plants essential oil concentration have increased antifungal activity against *B. cinerea*.

Ziziphus mauritiana extracts in different chemicals were also used against three FFP. It was observed that methanolic extract of *Ziziphus mauritiana* reduced the growth rate maximum of three dominant FFP named as *Aspergillus niger, Botrytis cinerea* and *Aspergillus ibericus*. Similar study conducted by Sivasankari et al. (2015). These scientists also described antifungal activity of *Ziziphus mauritiana* with ethanol and methanol extracts against *Trichoderma viride* and *Candida albicans*. Their ethanol leaf extract presented active results against *Trichoderma* viride and *Candida albicans*.

In current study extracts of *Butea monosperma* in Methanolic compound reduced maximum growth rate of selected FFP as compared to other three solvent extracts of selected medicinal plant. Similar study conducted by Senhaji et al. (2014), who also checked antifungal activity of four medicinal plants against grey mold of fruits caused by fungal pathogen *Botrytis cinerea*. The four organic plant extracts reduced completely the growth of *B. cinerea*. Moreover, some organic extracts showed no effect and some extracts showed reasonable antifungal effect on the fungal growth.

Overall, current study showed that methanolic extract of selected medicinal plant shows maximum antifungal activity against selected FFP as compared to other three solvent extracts of selected medicinal plant. Similar study reported by Onaran et al. (2016), who also described that Methanol extracts of some selected plant parts against fungal pathogens like *Botrytis cinerea, Alternaria solani* and *Rhizoctonia solani* have maximum zone of inhibition. The growth rates and zone of inhibition of fungal pathogens were also measured after each medicinal plants. The MPs treatments indicated positive correlation with FFP. In previous study Gehlot et al. (2013) also investigated the effect of methanol and aqueous

root and flower extracts of twenty-five desert plant species of Rajasthan against *Candida albicans* causal organism of 'Candidiasis' in human being. Of the total 100 plant part extracts tested, 22 had inhibitory effect against *Candida albicans*. The antifungal action of MPs named as "*Morus alba, Acacia modesta, Ziziphus mauritiana and Butea monosperma*" against three isolated FFP named as "*Aspergillus niger, Botrytis cinerea* and *Aspergillus ibericus*". All four plants show highest zone of inhibition against isolated FFP. Similar research was conducted by Hussain et al. (2015). These scientists also described antifungal activities of six medicinal plants a (*Acacia nilotica, Azadirachta indica*, *Crotalaria juncea Eucalyptus camaldulensis*, *Ocimum basilicum* and *Prosopis juliflora*) against five isolated fungal pathogens (*Aspergillus flavus*, *A. niger, Fusarium solani, Macrophomina phaseolina* and *Rhizoctonia solani*). All these plants showed good antifungal activity against the fungal pathogens but overall *Butea monosperma* have maximum response against FFP than *Acacia modesta, Ziziphus mauritiana* and *Morus alba*. We should focus on bio efficacy and single compound isolation of these medicinal plants in future for better control fungal diseases related to fruit plants.

CONCLUSION

It was concluded that *Butea monosperma* was more effective than *Acacia modesta, Ziziphus mauritiana* and *Morus alba* MPs. These findings indicated that the extract of medicinal plants greatly reduced the growth rate of fruit fungal pathogens. Furthermore, it was indicated that all the MPs have antifungal compounds or secondary metabolites but *Butea monosperma* may have more antifungal compounds which were more efficacy of diseases management. Hence, *Butea monosperma* recommended as excellent medicinal plant for control of diseases in future. However, further studies need to be directed to find the active chemical constituents present in these plants which are responsible for the antifungal effect and to calculate the cost and efficacy of these extracts on wide variety of diseases in viable greenhouses.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

TH designed and perform the field work, MI supervised the research work, SA conducted Lab work, MM guided and assisted in field work, FAK assisted in statistical analysis, WM helped in paper preparation, AG assisted in manuscript revision and polishing. All authors read and approved the final version.

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