Journal of Medicinal Plants Studies
www.PlantsJournal.com

ISSN 2320-3862
JMPS 2016; 4(4): 165-168

Received: 25-05-2016
Accepted: 27-06-2016

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Inhibitory activity of some plants against *Colletotrichum capsici* and *Fusarium oxysporum* f. sp. *zingiberi*

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Abstract
Interest in potential of botanical extracts against phytopathogenic fungi has increased due to some negative effects associated with the chemical fungicides. The present study was performed to determine antifungal activity of 27 plants (belonging to 26 genera and 14 families) collected from different places to Karnataka against two phytopathogenic fungi namely *Colletotrichum capsici* and *Fusarium oxysporum* f.sp. *zingiberi* by poisoned food technique. All extracts were efficient in inhibiting test fungi but to a varied extent. Marked inhibitory activity of extracts was observed against *C. capsici* when compared with *F. oxysporum* f.sp. *zingiberi*. Out of 30 extracts, 19 and 11 extracts exhibited an inhibitory activity of 50% and higher against *C. capsici* and *F. oxysporum* f.sp. *zingiberi* respectively. Highest and least inhibition of both fungi was displayed by *Curcuma aromatica* and *Vanda roxburghii* respectively. The botanical extracts used in this study appear to be promising agents capable of inhibiting phytopathogenic fungi. Further studies on inhibitory activity of these extracts against test fungi are to be carried in field conditions.

Keywords: Antifungal activity, botanical extracts, *Colletotrichum capsici*, *Fusarium oxysporum* f.sp. *zingiberi*, Poisoned food technique

Introduction
Production of crops for human use and consumption is profoundly influenced by biotic and abiotic factors. Factors such as lack or excess of water, nutrient supply, high or low temperature and high or low radiance are among important abiotic factors. Pests are the biotic factors which drastically reduce the crop yield and include agents such as insects, mites, nematodes, rodents, slugs and snails, birds, weeds, viruses, bacteria and fungi. Plants are important to us both aesthetically and economically and hence, effective management of plant diseases is absolutely essential. Among various aetiological agents causing plant diseases, fungi stands first as they cause more number of diseases both in agricultural and horticultural crops. Fungi are ubiquitous in natural and fungal infection of plants leads to crop losses, which may account for >50% in severe cases. They cause alterations in plants during developmental stages as well as during postharvest conditions (storage) leading to problems related to quality aspects such as varied organoleptic characteristics and nutritional values and reduced shelf life. Besides, some fungi elaborate toxins, for e.g., aflatoxins and ochratoxins in the food commodity which on consumption leads to health associated problems. An immense interest has been given to search fungicides of natural origin because of negative aspects associated with chemical fungicides. Pesticides from botanical origin are a part of integrated disease management employed in agriculture and are shown to be promising alternatives for control of phytopathogenic fungi [1-8]. In the present study, we evaluated the antifungal potential of 30 extracts from 27 plants belonging to 26 genera and 14 families collected from different places to Karnataka against two phytopathogenic fungi namely *Colletotrichum capsici* and *Fusarium oxysporum* f.sp. *Zingiberi*.

Materials and Methods
Collection and identification of plant materials
The plants were collected at different places of Karnataka such as Guddekeri, Lakkavalli, Shankaraghatta, Mullayanagiri, Bababudangiri, Thirthahalli, Sagara and Varadahalli during

2014-15. Some plants were purchased from local shops (Table 1). The plants were authenticated by referring standard flora and with the help of taxonomists [9-11].

Extraction

The plants were washed using clean water, dried under shade and powdered in a blender. Extraction of plant materials was carried out by simple maceration process. In this, the plant materials (10g) were transferred into separate conical flasks containing 100ml of methanol. The flasks were sealed and left for 48 hours with occasional stirrings. The contents of the flasks were filtered through Whatman No. 1 filter paper and the filtrates were evaporated to dryness at 50 ºC to obtain extract of plants [8].

Test fungi

Two fungi *viz.*, *Colletotrichum capsici* (causal agent of anthracnose of chilli) and *Fusarium oxysporum* f. sp. *zingiberi* (causal agent of rhizome rot of ginger) were used to assess their susceptibility to extracts of selected plants.

Antifungal activity of botanical extracts

The potential of botanical extracts to inhibit the selected phytopathogenic fungi was evaluated by poisoned food technique using potato dextrose agar medium. In brief, the control (without extract) and poisoned (0.5mg extract/ml of medium) potato dextrose agar plates were inoculated with the well sporulated culture of test fungi by point inoculation method. The plates were incubated in upright position at 28 ºC for 5 days. The inhibitory effect of plant extracts in terms of reduction in mycelial growth of test fungi was determined using the formula:

Antifungal activity (%) = (C – T / C) x 100, where C and T refers to diameter of fungal colonies on control and poisoned plates respectively [8].

Table 1: Plants used in this study

Sl. No.	Plant	Family	Part used
1	*Curcuma aromatica* Salisb.	Zingiberaceae	Rhizome
2	*Butea superba* Roxb.	Leguminosae	Leaf
3	*Argyreia speciosa* (L. f.) Sweet	Convolvulaceae	Leaf and Flower
4	*Adhatoda vasica* Nees	Acanthaceae	Leaf and Flower
5	*Nardostachys jatamansi* (D. Don) DC.	Caprifoliaceae	Root
6	*Putranjiva roxburghii* Wall	Putranjivaceae	Seeds
7	*Coscinium fenestratum* (Goetgh.) Colebr.	Menispermaceae	Stem
8	*Crotalaria filipes* Benth.	Leguminosae	Whole plant
9	*Swertia lawii* Burkill	Gentianaceae	Whole plant
10	*Conyza stricta* Willd	Compositae	Whole plant
11	*Syzygium laetum* (Buch.-Ham.) Gandhi	Myrtaceae	Leaf
12	*Blepharis asperrima* Nees	Acanthaceae	Whole plant
13	*Emilia sanchifolia* DC. ex DC.	Compositae	Whole plant
14	*Smithia sensitiva* Aiton	Leguminosae	Whole plant
15	*Striga gesnerioides* (Willd.) Vatke	Orobanchaceae	Whole plant
16	*Calceolaria mexicana* Benth.	Calceolariaceae	Whole plant
17	*Ziziphus xylopyrus* (Retz.) Willd	Rhamnaceae	Leaf and Fruit
18	*Eria mysorensis* Lindl.	Orchidaceae	Whole plant
19	*Bulbophyllum fischeri* Seidenf.	Orchidaceae	Whole plant
20	*B. neilgherrense* Wight	Orchidaceae	Whole plant
21	*Acampe praemorsa* (Roxb.) Blatter & McCann	Orchidaceae	Whole plant
22	*Dendrobium herbaceum* Lindl.	Orchidaceae	Whole plant
23	*Oberonia brunoniana* Wight	Orchidaceae	Whole plant
24	*Luisia macrantha* Blatt. McCann.	Orchidaceae	Whole plant
25	*Pholidota imbriacata* Lindl.	Orchidaceae	Whole plant
26	*Coelogyne nervosa* A.Rich.	Orchidaceae	Whole plant
27	*Vanda roxburghii* R.Br.	Orchidaceae	Whole plant

Results and Discussion

Economic loss due to plant diseases is one of the primary problems in crop cultivation and postharvest storage. Fungi are dominant group of phytopathogens and cause more number of diseases in various crops. Fungal diseases of plants are primarily controlled by the use of fungicides of chemical origin. However, the chemical fungicides are not eco-friendly as they are reported to have side effects such as carcinogenic, teratogenic and genotoxic properties. These agents are costly and also cause residual effects on environment and often lead to soil and ground water contamination. Often they cause depletion in the number of useful soil microbes. Several pathogenic fungi have developed resistance against fungicides because of constant use of fungicides. Hence, it is of great concern to search alternative strategies for disease prevention and control. Natural products are promising alternatives for chemical agents. Botanicals have been considered as an important part of integrated pest management. Studies have shown the potential of extracts and purified compounds from plants to inhibit fungal pathogens. Various phytochemicals such as phenolic compounds, alkaloids, essential oils and glycosides are effective against a range of phytopathogenic fungi [1, 12-17].

In the present study, 30 extracts from 27 plants were tested against *C. capsici* and *F. oxysporum* by poisoned food technique. This technique is one of the most widely used methods to evaluate antifungal efficacy of various kinds of samples including plant extracts. The result of inhibitory activity of plant extracts is shown in Table 2. Among fungi, marked inhibition by extracts was observed against *C. capsici*. Inhibition of *C. capsici* by extracts ranged between 21.05 to 87.47%. 19 out of 30 extracts inhibited *C. capsici* to 50% and higher. Inhibition of *F. oxysporum* by extracts ranged between 17.50 to 80% whereas in case of *F. oxysporum* 11 out of 30 extracts exhibited an inhibitory activity of 50% and higher. Highest and least inhibition of both fungi was displayed by *C. aromatica* and *V. roxburghii* respectively. In case of *A. vasica* and *A. speciosa*, leaf extracts exhibited high inhibitory activity when compared to flower extracts. Overall, extracts of orchids displayed low inhibitory activity against both the fungi. The inhibitory efficacy of some botanical extracts against *C. capsici* and *F. oxysporum* f.sp. *Zingiberi* has been observed by some researchers. The study of Shweta *et al.* [19] showed the antifungal activity of orchids namely *Luisia zeylanica*, *Dendrobium nutantiflorum*, *Pholidota pallida* and *Coelogyne breviscapa* against *C. capsici* and *F. oxysporum* f.sp. *Zingiberi*. Leaf and flower extract of *Aristolochia indica* were shown to inhibit both *C. capsici* and *F. oxysporum* f.sp. *Zingiberi* [20], however, the inhibition of *C. capsici* observed was least when compared to results of the present study. The study of Kambar *et al.* [18] showed the antifungal potency of 50 extracts from 35 plants in terms of inhibition of radial growth of *C. capsici*. In another study, Vivek *et al.* [21] observed inhibition of *C. capsici* by extract of *Memecylon malabaricum* and *M. talboltianum*. Similarly, Khan and Nasreen [6], Johnny *et al.* [22] and Zakari *et al.* [23] showed the efficacy of some plants against *C. capsici*. The study of Dileep *et al.* [24], Pandey *et al.* [25], Rakesh *et al.* [26] and Anusha *et al.* [27] highlighted the efficacy of some botanicals against *F. oxysporum* f.sp. *zingiberi*.

Table 2: Inhibition of test fungi by botanical extracts

Sl. No.	Plants	Part used	Colony diameter in cm (% inhibition)	
			C. capsici	***F. oxysporum***
1	Control	-	3.8	4.0
2	*C. aromatica*	Rhizome	0.4 (89.47)	0.8 (80.00)
3	*B. superba*	Leaf	0.7 (81.57)	2.0 (50.00)
4	*A. speciosa*	Leaf	1.2 (68.42)	1.8 (55.00)
5	*A. speciosa*	Flower	1.4 (63.15)	2.5 (37.50)
6	*A. vasica*	Leaf	1.0 (73.68)	2.0 (50.00)
7	*A. vasica*	Flower	1.2 (68.42)	2.4 (40.00)
8	*N. jatamansi*	Root	1.5 (86.84)	1.5 (62.50)
9	*P. roxburghii*	Seeds	0.9 (76.31)	2.0 (50.00)
10	*C. fenestratum*	Stem	0.8 (78.94)	1.6 (60.00)
11	*C. filipes*	Whole plant	2.0 (47.36)	1.8 (55.00)
12	*S. lawii*	Whole plant	1.2 (68.42)	1.2 (70.00)
13	*C. stricta*	Whole plant	0.8 (78.94)	1.2 (70.00)
14	*S. laetum*	Leaf	1.8 (52.63)	2.1 (47.50)
15	*B. asperrima*	Whole plant	1.5 (60.52)	2.1 (47.50)
16	*E. sanchifolia*	Whole plant	2.1 (44.73)	2.0 (50.00)
17	*S. sensitiva*	Whole plant	1.7 (55.26)	2.6 (35.00)
18	*S. gesnerioides*	Whole plant	2.0 (47.36)	2.5 (37.50)
19	*C. Mexicana*	Whole plant	1.6 (57.89)	2.2 (45.00)
20	*Z. xylopyrus*	Leaf	2.6 (31.57)	2.9 (27.50)
21	*Z. xylopyrus*	Fruit	2.6 (31.57)	3.0 (25.00)
22	*E. mysorensis*	Whole plant	2.3 (39.47)	2.7 (32.50)
23	*B. fischeri*	Whole plant	2.4 (36.84)	2.5 (37.50)
24	*B. neilgherrense*	Whole plant	1.9 (50.00)	2.3 (42.50)
25	*A. praemorsa*	Whole plant	2.8 (26.31)	3.0 (25.00)
26	*D. herbaceum*	Whole plant	1.8 (52.63)	2.8 (30.00)
27	*O. josephi*	Whole plant	2.3 (39.47)	2.5 (37.50)
28	*L. macrantha*	Whole plant	2.3 (39.47)	3.1 (22.50)
29	*P. imbriacata*	Whole plant	1.6 (57.89)	2.9 (27.50)
30	*C. nervosa*	Whole plant	1.2 (68.42)	2.5 (37.50)
31	*V. roxburghii*	Whole plant	3.0 (21.05)	3.3 (17.50)

Conclusion

Plant diseases caused by pathogens challenge agricultural production by causing crop loss. Natural products are gaining more interest due to the drawbacks associated with synthetic fungicides. In the present study, the extracts of plants appear to be effective against test fungi. From the results of the present study, it can be concluded that the plants selected in this study may be used as potential alternates for synthetic fungicides. However, these botanicals can be recommended only after field experiments.

Acknowledgements

Authors thank Principal, S.R.N.M.N College of Applied Sciences and N.E.S, Shivamogga for the facilities provided and moral support. Authors also thank Prof. D. Rudrappa, Dr. E.S. Kumaraswamy Udupa and Mrs. Ashwini H.S for helping in the identification of plants.

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