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Plant Metabolites- A Brief Review on Natural Approach to Combat Plant Pathogenic Infections

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ABSTRACT: The productivity of agricultural crops is severely affected by various plant pathogens, among which bacteria and fungi are causing the major crop destructions. The crop damage caused by these plant pathogens are causing major threats to global food production and turns out to be a worldwide problem. Commercial pesticides used to control these plant pathogens are causing detrimental effects on human health and environment. Therefore, scientists are approaching a safe and environment friendly method to combat this crisis where plant metabolites are used as bio-pesticides. Various investigations on plant metabolites and its potential in eradicating plant pathogens, makes it the most effective alternative solution to chemical pesticides. But such works are not compiled systematically to gather knowledge about their affectivity and mode of use for further investigation. So, in this article, some lists are compiled for plant metabolites that were used as effective bio-pesticides in controlling several infectious plant diseases caused by bacteria and fungi.

Keywords: Metabolites, Synthetic, Resistance, Biodegradation, Toxicity, Pollutants.

INTRODUCTION

Plant diseases are causing major problem in global food production as it is affecting growth and production of all the important crops. The rising temperature of the Earth's surface due to global warming is a major cause of increasing the number of diseases and occurrence of many pesticide resistant plant pathogens. The agricultural crops are infected by many pathogens such as bacteria, fungi etc (Kotan *et al*., 2010). Generally, rapid and effective control of plant disease and microbial contamination in the crops is generally achieved using synthetic pesticides and antibiotics. Plant diseases are hard to control because only a few of the commercial bactericides, fungicides are available so far and restrictions on the use of antibiotics in many countries is also a cause (Spiroudi *et al*., 2000). Commercial antibiotics, copper compounds and synthetic pesticides to control various plant pathogenic bacteria has helped to combat the bacterial infection, but their long-term use had lead to severe environmental pollutions, disease resistance by the target pathogens and residual toxicity (Nguyen *et al*., 2017). Again antibiotics like streptomycin and oxytetracyclin were most commonly used against bacterial pathogens. Although, use of synthetic pesticide is a popular way of controlling pests because it is cheap, effective and has direct results but causing harmful effects on the humans. Thus, public concerns have been raised over pesticide residues on fruits and food conventional pesticides that have caused extensive side effects on ecological sustainability, health safety of farmers and consumers and ecological biodiversity. The side effect of such pesticides remains for years because of their longstanding biodegradation in the ecosystems and accumulation in the food chain (Dadasoglu *et al*., 2015; Pimentel and Greiner 1997; Paster and Bullerman 1988; Kalyan *et al*., 2022). Overuse of such chemical pesticides has also caused soil acidification, groundwater contamination, destruction of ecosystems and toxicity to humans and animals. Similarly, synthetic fungicide residues also possess serious health risks to consumers and prolonged use of such fungicides leads to an increase the disease resistance capacity of the pathogens. Furthermore, the use in crop protection of many synthetic fungicides that have various degrees of persistence has now been cautioned due to their carcinogenicity, teratogenicity and other residual toxicities. Several synthetic fungicides are reported to cause adverse effects on treated soil ecosystems because of their non-biodegradable nature (Tegegnea *et al*., 2008; Castillo *et al*., 2010). Therefore, the deleterious effects of synthetic pesticides on human and plant health are constantly creating an urgent need for alternative agents for the management of pathogenic microorganisms (Mahajan and Das 2003).

The increasing number of pesticides resistance is demanding for the generation of new and potent pesticides which are environment friendly. All of these, human health and environmental problems are making scientists to search for a biological alternative which can meet the consumers demand as well as protecting the environment from pollutants (Wilson *et al*., 1997; Gahukar, 2012). The popularity of botanical pesticides is increasing day by day and some of the plant products are used as green pesticides all over the world (Dubey *et al*., 2008). A green plant generally contains a reservoir of effective novel chemo-therapeutants with different mode of action which can provide valuable sources of natural pesticides against all kind of resistant and non-resistant plant pathogens (Newman *et al*., 2000; Gibbons, 2005). Many investigations were carried out on plants containing natural antimicrobial metabolites which are present in plant as a form of secondary metabolites that protects the plant from various pathogens and adverse environmental condition. Thus they can be used as an effective method of disease control (Seint and Masera 2011). There are various types of plant products like plant extracts, essential oils, gums and resins, which have shown strong biological activities on fungal and bacterial plant pathogens (Al-Askar and Rashad 2010). Plant-based antimicrobials have enormous therapeutic potential that serve the purpose with lesser side effects than synthetic antimicrobials. There are some advanced biological approaches like biological control options in which antagonistic microorganisms or microbial pesticides are used as effective alternatives against the phytopathogens for their reduced toxicity, good biodegradability and eco-friendly nature (Cha *et al*., 2002; Jo *et al*., 2008). The screening and testing of the efficacy of plants for antibacterial activity were underway to explore antibacterial activity of many medicinal plants (Bhardwaj and Laura 2009; Pandey *et al*., 2021) and a review in this field will help to find different botanicals which can inhibit growth of phytopathogens (Pandit *et al*., 2022) which can be used to formulate pesticides which will be eco-friendly and cost effective. In this review, we would like to document some of the plants used against plant pathogenic bacteria and fungi and these plants are evidenced to be highly effective.

METHODOLOGY

This study is based on secondary data. The data were collected from various significant research works published on renowned journals and books depicting the actions of various plant metabolites against plant pathogens. A thorough study has been carried out to prepare this article.

RESULT AND DISCUSSION

Plant products are safe and most effective alternatives for the growing pathogen resistant pesticides and antibiotics. Agricultural crops are everyday affected by bacterial and fungal pathogens and as a result, scientists are trying hard to find plant that can be efficient alternatives to synthetic chemicals. Some of them are discussed below that show tremendous effect against both bacterial and fungal plant pathogens. The bacterial pathogens effecting plants are mainly *Pseudomonas syringae pathovars*, *Ralstonia solanacearum*, *Agrobacterium tumefaciens*, *Xanthomonas oryzae pv. oryzae*, *Xanthomonas campestris pathovars*, *Xanthomonas axonopodis pathovars*, *Erwinia amylovora*, *Xylella fastidiosa*, *Pectobacterium carotovorum* etc (Mansfied *et al*., 2012). In Table 1, we can see the infections caused by bacterial phyto-pathogens like *Xanthomonas* spp., *Pseudomonas* spp., *Rhizobium* spp., *Erwinia* sp., *Agrobacterium* sp., *Bacillus* sp., *Clavibacter* spp., *Staphylococcus spp.* that are being treated with the help of various common medicinal plants. The plants belongs to families like Lamiacea, Lauraceae, Fabaceae, Geraniaceae, Leguminosaceae, Asteraceae, Asparagaseae, Araceae, Amaranthaceae, Rutaceae, Piperaceae, Malvaceae, Pedaliacea, Theaceae, Pedaliaceae, Apiacea, Pedaliaceae, Phyllanthaceae, Rhamnaceae, Bignoniaceae. Some plant shows effective control against more than one bacterial pathogen like for example; *Origanum rotundifolium* is effective against *Agrobacterium tumefaciens, Bacillus pumilus*, *Clavibacter michiganensis*, *Pseudomonas s.pv. savastanoi*, *Erwinia caratovora*, *Pseudomonas corrugate*; *Persea macrantha* is effective against *Pseudomonus syringe*, *Xanthomonas orayzae* and *Xanthomonas vesicatoria*; *Piper sarmentosum* Roxb. is effective against *Pseudomonas fuscovaginae* and *Xanthomonas oryzae*; *Sida cordifolia* L. is effective against *Bacillus subtilis* and *Staphylococcus aureus*; *Ziziphus mauritiana* Lam is effective against *E. coli* and *Xanthomonas a. pv. Malvacearum.*

Table 1: Antimicrobial activity of plants against plant pathogenic bacteria.

Sr. No.	Scientific name of plant	Family	Parts used	Target plant pathogen	Mode of use	Reference
1.	*Asparagus racemosus* Willd.	Asparagaceae	Root	*Xanthomonas campestris pv. Campestris*	Water extract	Bhardwaj and Laura (2009)
2.	*Acacia nilotica* (L.)Delile	Leguminosae	Leaf	*Xanthomonas campestris pv. Vesicatoria*	Methanol extract	Kavitha and Satish (2011)
3.	*Acorus calamus* L.	Araceae	Rhizome	*Erwinia carotovora*	Ethanol extract	Kavitha and Satish (2011)
4.	*Achyranthus asper* L.	Amaranthaceae	Bark	*Xanthomonas campestris pv. Campestris*	Water extract	Bhardwaj and Laura (2009)
5.	*Acacia catechu* (L.f.) Willd.	Fabaceae	Bark	*Xanthomonas campestris pv. Campestris*	Water extract	Bhardwaj and Laura (2009)
6.	*Aegle marmelos* (L.) Correa	Rutaceae	Fruit	*Xanthomonas campestris pv. Campestris*	Water extract	Bhardwaj and Laura (2009)
7.	*Carum copticum* L.	Apiaceae	Seed	*Xanthomonas oryzae pv. oryzae*	Methanol extract	Kavitha and Satish (2011)
8.	*Camellia sinensis* (L.) Kuntze	Theaceae	Leaves	*Xanthomonas campestris pv. Campestris*	Water extract	Bhardwaj and Laura (2009)
9.	*Emblica officinalis* Gatertn	Phyllanthaceae	Leaves	*Xanthomonas campestris pv. vesicatoria*	Methanol extract	Kavitha and Satish (2011)
10.	*Eupatorium odaratum* (L.) R.M.King&H.Rob.	Asteraceae	Leaves	*Xanthomonas oryzae pv oryzae*	Ethanol extract	Kavitha and Satish (2011)
11.	*Foeniculum vulgare* Mill.	Apiacea	Seeds	*Rhizobium radiobacter*	Essential oil	Bozcurt *et al.* (2020)
12.	*Hyptis suaveolens* (L.) Poit	Lamiaceae	Leaves	*Xanthomonas campestris pv. vesicatoria.*	Methanol extract	Kavitha and Satish (2011)
13.	*Laurus nobilis* L.	Lauraceae	Leaves	*Rhizobium radiobacter*	Essential oil	Bozcurt *et al.* (2020)
14.	*Lavandula stoechas* L. var. stoechas	Lamiaceae	Leaves	*Pseudomonas s.pv. savastanoi*	Essential oil	Bozcurt *et al.* (2020)
15.	*Millingtonia hortensis* L.fil.	Bignoniaceae	Leaf	*Xanthomonas oryzae pv oryzae*	Methanol	Kavitha and Satish (2011)
16.	*Mentha spicata* L.	Lamiaceae	Leaves	*Rhizobium radiobacter*	Essential oil	Bozcurt *et al.* (2020)
17.	*Melissa officinalis* L.	Lamiaceae	Leaves	*Pseudomonas s.pv. savastanoi*	Essential oil	Bozcurt *et al.* (2020)
18.	*Origanum rotundifolium* (DC.) Norl.	Geraniaceae	Leaves, flower and stems	*Agrobacterium tumefaciens*	Essential oil	Gormez *et al.* (2016)
19.	*Origanum rotundifolium* (DC.) Norl.	Geraniaceae	Leaves, flower and stems	*Bacillus pumilus*	Essential oil	Gormez *et al.* (2016)
20.	*Origanum rotundifolium* (DC.) Norl.	Geraniaceae	Leaves, flower and stems	*Clavibacter michiganensis subsp. michiganensis*	Essential oil	Gormez *et al.* (2016)
21.	*Origanum majorana* L.	Lamiacea	Leaves	*Pseudomonas s.pv. savastanoi*	Essential oil	Bozcurt *et al.* (2020)
22.	*Origanum syriacum* L.	Lamiacea	Leaves	*Pseudomonas s.pv. savastanoi*	Essential oil	Bozcurt *et al.* (2020)
23.	*Origanum rotundifolium* (DC.) Norl.	Geraniaceae	Leaves, flower and stems	*Erwinia caratovora caratovora*	Essential oil	Gormez *et al.* (2016)
24.	*Ocimum basilicum* L.	Lamiaceae	Leaves	*Rhizpbium radiobacter*	Essential oil	Bozcurt *et al.* (2020)
25.	*Origanum rotundifolium* (DC.) Norl.	Geraniaceae	Leaves, flower and stems	*Pseudomonas corrugate*	Essential oil	Gormez *et al.* (2016)
26.	*Origanum rotundifolium* (DC.) Norl.	Geraniaceae	Leaves, flower and stems	*Pseudomonas syringae pv. Syringae*	Essential oil	Gormez *et al.* (2016)

27.	*Ocimum gratissimum* L.	Lamiaceae	Leaf	*Xanthomonas axonopodis pv. Malvacearum*	Chloroform extract	Kavitha and Satish (2011)
28.	*Parkia biglandulosa* Wight &Arn.	Fabaceae	Leaves, stems etc	*Crinum latifolium*	Water extract	Shrisha *et al* .(2011)
29.	*Persea macrantha* (Nees) Kosterm.	Lauraceae	Leaves, stems etc	*Pseudomonas Syringae*	Ethyl acetate extract	Shrisha *et al.* (2011)
30.	*Persea macrantha* (Nees.) Kosterm	Lauraceae	Leaves, stems etc	*Xanthomonas orayzae*	Ethyl acetate extract	Shrisha *et al.* (2011)
31.	*Persea macrantha* (Nees.) Kosterm	Lauraceae	Leaves, stems etc	*Xanthomonas vesicatoria*	Ethyl acetate extract	Shrisha *et al.* (2011)
32.	*Piper sarmentosum* Roxb.	Piperaceae	Fruits and leaves	*Pseudomonas fuscovaginae*	Methanol extract	Rahman *et al.* (2014)
33.	*Piper sarmentosum* Roxb.	Piperaceae	Fruits and leaves	*Xanthomonas oryzae*	Methanol extract	Rahman *et al.* (2014)
34.	*Pedalium murex* L.	Pedaliaceae	Leaves	*Xanthomonas c. pv. Vesicatoria*	Methanol extract	Kavitha and Satish (2011)
35.	*Pharbitis nil* L.	Convolvulaceae	Seeds	*Xanthomonas axonopodis pv. Citri*	Butanol extract	Nguyen *et al.* (2017)
36.	*Rosmarinus officinalis* L.	Lamiaceae	Leaves	*Pseudomonas s.pv. savastanoi*	Essential oil	Bozcurt *et al.* (2020)
37.	*Salvia officinalis* L.	Lamiacea	Leaves	*Rhizobium radiobacter*	Essential oil	Bozcurt *et al.* (2020)
38.	*Sida cordifolia* L.	Malvaceae	Leaves	*Bacillus subtilis*	Methanol extract	Mahesh and Satish (2008)
39.	*Sidacordifolia* L.	Malvaceae	Leaves	*Staphylococcus aureus*	Methanol extract	Mahesh and Satish (2008)
40.	*Tagetes minuta* L.	Asteraceae	Leaves, flowers and stems	*Pseudomonas savastanoi pv. Phaseolicola*	Essential oil	Gakuubi *et al.* (2016)
41.	*Thymus serpyllum* L.	Lamiaceae	Leaves	*Pseudomonas s.pv. savastanoi*	Essential oil	Bozcurt *et al.* (2020)
42.	*Thymbra spicata var. spicata* L.	Lamiaceae	Leaves	*Rhizobium radiobacter*	Essential oil	Bozcurt *et al.* (2020)
43.	*Thymus sipyleus* Boiss.	Lamiaceae	Leaves	*Pseudomonas s.pv. savastanoi*	Essential oil	Bozcurt *et al.* (2020)
44.	*Ziziphus mauritiana* Lam.	Rhamnaceae	Leaves	*Escherechia coli*	Methanol extract	Mahesh and Satish, (2008)
45.	*Ziziphus mauritiana* Lam.	Rhamnaceae	Leaves	*Xanthomonas a. pv. Malvacearum*	Methanol extract	Mahesh and Satish (2008)
46.	*Syzygium aromaticum* (L.) Merr. & L.M.Perry	Myrtaceae	Leaves	*Ralstonia solanacearum*	Essential oil	Marry *et al.* (2022)
47.	*Linum usitatissium* L.	Linaceae	Leaves	*Ralstonia solanacearum*	Essential oil	Marry *et al.* (2022)

In Table 2, there are also many plants which show affectivity against more than one fungal pathogen. *Eichhornia crassipes* shows activity against 6 pathogens namely *Aspergillus flavus, Aspergillus niger, Alternaria alternate, Colletotrichum gloeosporioides, Fusarium solani and Candida albicans*. Similarly, *Moringa officinale* shows activity against 6 fungal pathogens, *Dendrocalamus hamiltonii* shows activity against 5 fungal pathogens, *Piper betel* against 4 fungal pathogens, *Bucida buceras* shows activity against 3 fungal pathogens and *Melaleuca alternifolia* against 2 fungal pathogens respectively. According to Dean *et al.* (2012), the most prevalent fungal plant pathogens are like *Fusarium graminearum*, *Fusarium oxysporum*, *Colletotrichum* spp. etc. The plants are used against the pathogens in the form of plant extracts and essential oils. Plant extracts have various secondary metabolites such as alkaloids, flavanoids, steroids/ terpenoids, quaternary alkaloids, coumarins, phenols (Chopra, 1992) which shows antimicrobial activities against phytopathogenic bacteria and fungi (Korpe *et al*., 2012; Mahlo *et al*., 2010). The essential oils exhibited antimicrobial against seed borne bacterial plant pathogens and they are more effective due to low molecular weight and lipophilic tendencies. The component of essential oil has allowed them to penetrate cell membranes quickly which are 100 times faster than water and 10,000 times faster than salts (Burt *et al*., 2005; Edris, 2007). Thus, essential oil could be developed as an effective natural pesticide for agricultural applications (Joeng *et al*., 2009).

Table 2: Antimicrobial activity of plants against fungal plant pathogens.

Sr. No.	Scientific name of the plant	Family	Parts used	Target pathogen	Mode of use	References
1.	*Bucida buceras* (L.) C.Wright	Combretaceae	Leaves	*Penicillium. Expansum*	Aceton extract	Mahlo *et al*. (2010)
3.	*Bucida buceras* (L.) C. Wright	Combretaceae	Leaves	*Trichoderm aharzianum*	Aceton extract	Ushiki *et al*. (1996)
4.	*Bucida buceras* (L.) C.Wright	Combretaceae	Leaves	*Fusarium oxysporum*	Aceton extract	Ushiki *et al*. (1996)
5.	*Curcuma longa* L.	Zingiberaceae	Spice	*Collitotrichum fragariae*	Methanol extract	Radwan *et al*. (2014)
6.	*Cymbopogon citrates* Stapf.	Poaceae	Leaves	*Colletotrichum gloeosporioides*	Essential oil	Jeong *et al*. (2009)
7.	*Calocedrus macrolepis var. formosana*	Cupressaceae	Leaves	*Rhizoctonia solani*	Essential oil	Chang *et al*. (2008)
8.	*Calocedrus macrolepis var. formosana*	Cupressaceae	Leaves	*Pestalotiopsis funereal*	Essential oil	Chang *et al*. (2008)
9.	*Dendrocalamus hamiltonii* Nees and Arn. Ex Munro	Apocyanaceae	Rhizome	*Penicillium chrysogenum*	Water extract	Mohana and Raveesha (2007)
10.	*Dendrocalamus hamiltonii* Nees and Arn. Ex Munro	Dendrocalamus	Rhizome	*Drechslera halodes*	Water extract	Mohana and Raveesha (2007)
11.	*Dendrocalamus hamiltonii* Nees and Arn. Ex Munro	Dendrocalamus	Rhizome	*Aspergillus fumigates*	Water extract	Mohana and Raveesha (2007)
12.	*Dendrocalamus hamiltonii* Nees and Arn. Ex Munro	Dendrocalamus	Rhizome	*Fusarium lateritium*	Water extract	Mohana and Raveesha (2007)
13.	*Dendrocalamus hamiltonii* Nees and Arn. Ex Munro	Dendrocalamus	Rhizome	*Fusarium moniliforme*	Water extract	Mohana and Raveesha (2007)
14.	*Eichhornia crassipes* (Mart.) Solms	Pontederiaceae	Leaves	*Aspergillus flavus*	Water extract	Haggag *et al*. (2017)
15.	*Eichhornia crassipes* (Mart.) Solms	Pontederiaceae	Leaves	*Aspergillus niger*	Water extract	Haggag *et al*. (2017)
16.	*Eichhornia crassipes* (Mart.) Solms	Pontederiaceae	Leaves	*Alternaria alternate*	Water extract	Haggag *et al*. (2017)
17.	*Eichhornia crassipes* (Mart.) Solms	Pontederiaceae	Leaves	*Colletotrichum gloeosporioides*	Water extract	Haggag *et al*. (2017)
18.	*Eichhornia crassipes* (Mart.) Solms	Pontederiaceae	Leaves	*Fusarium solani*	Water extract	Haggag *et al*. (2017)
19.	*Eichhornia crassipes* (Mart.) Solms	Pontederiaceae	Leaves	*Candida albicans*	Water extract	Haggag *et al*. (2017)
20.	*Geranium pretense* L.	Geraniaceae	Root	*Sacroptes scabies*	Water extract	Ushiki *et al*. (1996)
21.	*Geranium pretense* L.	Geraniaceae	Root	*Phytophthora megasperma*	Water extract	Ushiki *et al*. (1996)
22.	*Moringa oliefera* Lam	Moringaceae	Roots	*Fusarium oxysporum*	Water extract	Mohamedy and Abdalla (2014)
23.	*Melaleuca alternifolia* (Maiden &Betche) Cheel	Myrtaceae	Leaves	*Pyrenophora graminea*	Essential oil	Terzi *et al*. (2007)
24.	*Melaleuca alternifolia* (Maiden &Betche) Cheel	Myrtaceae	Leaves	*Fusarium graminearum*	Essential oil	Terzi *et al*. (2007)
25.	*Moringa oliefera* Lam	Moringaceae	Roots	*Fusarium solani*	Water extract	El-Mohamedy and Abdalla (2014)
26.	*Moringa oliefera* Lam	Moringaceae	Roots	*Alternaria solani*	Water extract	El-Mohamedy and Abdalla (2014)
27.	*Moringa oliefera* Lam	Moringaceae	Roots	*Alternaria alternate*	Water extract	El-Mohamedy and Abdalla (2014)
28.	*Moringa oliefera* Lam	Moringaceae	Roots	*Sclerotium rolfsii*	Water extract	El-Mohamedy and Abdalla (2014)
29.	*Moringa oliefera* Lam	Moringaceae	Roots	*Macrophonia phaseolina*	Water extract	El-Mohamedy and Abdalla (2014)
30.	*Piper betel* L.	Piperaceae	Leaves	*Colletotrichum capsici*	Ethanol extract	Singburaudom (2015)
31.	*Piper betel* L.	Piperaceae	Leaves	*Colletotrichum gloeosporioides*	Ethanol extract	Singburaudom (2015)
32.	*Piper betel* L.	Piperaceae	Leaves	*Sphaceloma ampelinum*	Ethanol extract	Singburaudom (2015)

33.	*Piper betel* L.	Piperaceae	Leaves	*Fusarium oxysporum f. sp. Cubense*	Ethanol extract	Singburaudom (2015)
34.	*Sanguisorba officinalis* L.	Rosaceae	Root	*Phytophthora megasperrna*	Water extract	Ushiki *et al*. (1996)
35.	*Syzygium aromaticum* L.	Myrtaceae	Spice	*Colletotrichum fragariae*	Methanol extract	Ratwan *et al*. (2014)
36.	*Trema orientalis* L. Blume	Cannabaceae	Leaves	*Ascochyta rabiei*	Water extract	Onaran and Yilar (2015)
37.	*Trema orientalis* L. Blume	Cannabaceae	Leaves	*Rhizoctonia solani*	Water extract	Onaran and Yilar (2015)
38.	*Trema orientalis* L. Blume	Cannabaceae	Flower	*Verticillium dahlia*	Water extract	Onaran and Yilar (2015)
39.	*Zingiber officinale* Roscoe	Zingiberaceae	Spice	*Colletotrichum fragariae*	Methanol extract	Ratwan *et al*. (2014)
40.	*Ailanthus excelsa* Roxb.	Simaroubaceae	Leaves	*Golovinomyces cichoracearum*	Water extract	Kavyasri *et al.* (2022)
41.	*Allium sativum* L.	Amaryllidaceae	Bulb	*Cercospora canescens*	Water extract	Raghubanshi *et al.* (2022)

CONCLUSIONS

As there are several concerns over excessive use of synthetic pesticides and their polluting nature that causes soil pollution impacting our human health to a great extend. Therefore, there is an urgent need to initiate more studies on finding plant alternatives for the synthetic pesticides. From the above observation, it was clear that many plants are effectively controlling the growth of various prevalent plant pathogens. Our nature is full of medicinal plants which are surrounded by numerous potent plants that are capable of giving promising results. These plants can be used against plant pathogens and thus, it can reduce the toxic effects of synthetic pesticides and can preserve our natural ecosystem from biodegradation as the plant derived products like essential oil, plant crude extracts have low mammalian toxicity, less adverse environmental effects and wide public acceptance.

FUTURE SCOPE

In this review paper, we have discussed few plants showing antimicrobial activity against both bacterial and fungal pathogens but our biodiversity is filled with numerous medicinal plants which can also be tested against most prevalent bacterial and fungal pathogens as well as on their resistant varieties. These promising biological plant pesticides can save us from many health complications and also, can protect our environment from pollution effects caused by synthetic pesticides.

Conflict of Interest. None.

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