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Review Paper

A Review on the Antimicrobial Activity of an Important Medicinal Plant *Inularacemosa* Hook. F.

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Abstract
Microbial infections whether in humans or in plant have posed a great challenge in front of us. The emergence of microbial resistance to the currently available anti-microbial agents necessitates the futher research in the discovery of new safe and effective anti-microbial agents. The medicinal plants have shown a promising alternative for the treatment of infectious diseases. Many plant-derived products such as phenols, quinones, terpenes, saponins and alkaloids have been used safely for antimicrobial purposes in the Indian and Chinese traditional medicine with little risk of animal toxicities. For this reason, some phytochemicals are receiving growing attention aiming at developing hopefully new indigenous, nontoxic, biodegradable and renewable pesticides. The root of Inula racemosa Hook f. is a traditional medicinal herb frequently used as antimicrobial agents since ancient times. Phytochemical investigation of the plant showed the presence of alantolactone, isoalantolactone, dihydroalantolactone, dihydroisoalantolactone, sitisterol, daucosterol, inunolide, aplotaxene, phenylacetonitrile and isoinunal. Recently, the active compound of antimicrobial activity characterized as isoalantolactone, which happens to be the most abundant constituent of the plant. Available literature indicates that the constituents of Inula racemosa Hook. F. and the plant extract have shown a great success as an antimicrobial agent both in human and plants.

Key words: *Microbial infection, anti-microbial agents, phytochemicals, Inula racemosa Hook f.*

Introduction

Antimicrobial activity of Inula racemosa Hook. f. in humans

Synthetic pesticides are widely applied to plant protection. Many of such chemicals, not easily degradable in field, are suspected of environmental pollution, leading to residual toxicity such as carcinogenicity and teratogenicity (1). Furthermore, repetitious applications of these agrochemicals make pests develop resistance (2). Accordingly, there is an urgent need to search for new highly effective and safe (or easily biodegradable) chemicals that will be expected to be more advantageous in plant protection. Many plant-derived products such as phenols, quinones, terpenes, saponins and alkaloids have been used safely for antimicrobial purposes in the Indian and Chinese traditional medicine with little risk of animal toxicities (3, 4). For this reason, some phytochemicals are receiving growing attention aiming at developing hopefully new indigenous, nontoxic, biodegradable and renewable pesticides (5-7). The root of *Inula racemosa* Hook f. (Compositae) is a traditional Chinese medicinal herb (called Tumuxiang) frequently used as antimicrobial agents since ancient times. Phytochemical investigation of the plant showed the presence of sesquiterpene lactones like alantolactone, iaoalantolactone, dihydroalantolactone, dihyroisoalantolactone, sitisterol, daucosterol, inunolide, aplotaxene, phenylacetonitrile and isoinunal which shows high antimicrobial activity whether in plantsor in humans (8).

According to the study, isoalantolactone, a major constituent of *Inula racemosa* shows high activity against microbes. It was tested for its antimicrobial action187 against five bacteria, six human and six plant pathogenic fungi. The lactone showed absolute toxicities at 500µg/mL against 3 soil borne phytopathogenic fungi (*Gaeumannomycesgraminis*var. *tritici*, *Rhizoctoniacerealis*and *Phytophthora capsici*) with the MICs determined to be 100,100 and 300 µg/mL, respectively. At the MICs, isoalantolactoneexhibited its fungistatic nature of toxicity. The lowest fungicidal concentrations of the lactone to *G. graminis*var.*tritici*, *R. cerealis*and *P. capsici*were shown to be 150, 150and 350 µg/mL, respectively. Moreover, isoalantolactone displayed weaker antibacterial activities against *Bacillussubtilis*, *Escherichia coli*, *Pseudomonas fluorecense*, *Sarcinalentus*and *Staphylococcus aureus*with MICs of 125, 425, 150, 150 and 100 µg/mL, respectively. The investigation disclosed the strong inhibition of isoalantolactone to the phytopathogenic fungi, raising a possibility that the lactone could be considered as a starting point for the project aiming at the development of new fungicides (9). Some of the sesquiterpene lactones of *Inula racemosa* has the pharmacological activities (10). Alantolactone and isoalantolactone are the major constituent of *Inula racemosa,* they possess anti-fungal and anti-helmintic activities (11). Isoalantolactone isolated from the methanol roots extract of *I. racemosa*was evaluated for antifungal activity against the human pathogenic fungi *Aspergillus flavus, Aspergillus niger, Geotrichum candidum,*

*Candida tropicali s*and *Candida albicans*. The tested compound inhibited the growth of *A. niger, A. flavus, G. candidum, C. albicans* and *C. tropicalis*with MICs values 50, 50, 25, 25 and 25 µgmL−1 respectively (12).

Antibacterial activity of the ethanol and aqueous roots extract of *I. racemosa* was evaluated by disc diffusion method against *E. coli* and *S. aureus*. The aqueous extract of the plant exhibited significant antimicrobial activity for these two microorganisms tested, with MIC values of 6.25 mgmL−1 and 12.5 mgmL−1 respectively, whereas ethanol extract also had potent activity against microorganisms, with MIC of 15.625 mgmL−1 (13). The resistance of different bacteria to the current antibacterial agents, toxicity or the antibacterial agents and the cost of the treatment have led to the development of new active molecules against the bacteria. Since, ancient time's medicinal plants have been used for the treatment of bacterial infections. The roots of the plant *Innula racemosa* has been used as folk medicine in East Asia and Europe. However, no systematic data is available on the antibacterial activity profile of different constituents of *Innula racemosa.* In the present studies, attempt has been made for the isolation of root constituents of *Innula racemosa* and evaluation of its antibacterial activity. The constituents were isolated and purified by column chromatography. The structure of the isolated constituents was confirmed by the spectral analysis and was used for the determination of the antibacterial activity of *Innula racemosa* against various microorganisms. The constituent's alantolactone showed maximum antibacterial activity as compared to the other constituents and ethyl acetate extract of roots (14).

Antimicrobial activity of Inula racemosa Hook. f. in Plants:

Plant pathogens cause great losses to agricultural crops and thus threaten food resources all over the world (15). A significant portion of the agricultural produce in the country and the world over become unfit for human consumption due to mycotoxins contamination produced by species of *Aspergillus* (16, 17, 18), *Aspergillius niger* as a strong pathogen can cause the rotting of numerous fruits and vegetable (19, 20) (21 22) such as black rot of onion and rot of tomato (23, 24). *Aspergillus flavus* is a weak opportunistic and a mycotoxigenic fungus and infects several agricultural crops (25). These pathogenic fungi not only involve in food spoilage by retarding its nutritive value (26, 27) but also involve in many fungal infections. The toxin produced by them shows the effect of carcinogenicity, genotoxicity, teratogenicity, nephrotoxicity, hepatotoxicity, reproductive disorders (28, 29, 30) on consumption of spoiled food. The disease in crop caused by phytopathogenic fungi is mainly controlled by synthetic fungicides. However, the application of this agrochemical is increasingly restricted due to the harmful effects of pesticides on human health and the environment (31). In many countries the use of synthetic fungicide has been banned due to the non-biodegradability, residual toxicity, pollutative nature. In order to have safe methods for plant disease control in sustainable agriculture there is a need for reducing the use of synthetics chemicals fungicides there by replacing it with biocides with plant origin. Plants are known to produce a variety of compounds to protect themselves against a variety of pathogens. The plants are rich sources of numerous bioactive secondary metabolites such as alkaloid, flavonoids, terpenoids, saponins, tannins and phenolic compounds which are the important sources of microbiocides, pesticides, antifungal activity and many pharmaceutical compounds (32, 33). Thus plant extracts which is a source of natural pesticides can be developed into new biocidal pesticides (34, 35). Therefore the present study investigate; the efficacy of various high altitude medicinal plant extracts from *Codonopsisclematidea, Hippo phaerhamnoides, Artimesia dracunculus, Galiumaparine, Mentha longifolia, Foeniculumvulgare, Rubia coradifolia, Saussure alappa, Inula racemosa, Rheum webbianum, Arnebia euchroma, Rhodia laheterodanta, Rhodia laimbericate, Achelia millefolium and Hypericum perforantum,* for the thirst of antifungal property against the two *Aspergillus spp.,* through *in vitro* analysis. Recent efforts have focused on development of environmentally safe, long lasting and effective biocontrol methods for the management of plant diseases.

Alternaria solani causes early blight in plants belonging to family Solanaceae. It severely infests agriculturally important crops like tomato and potato at different developmental stages. We have screened eighty one extracts of twenty seven medicinally important plants for their antifungal activity against *A. solani*. Twelve extracts of eight plants (*Cinnamom umzeylanicum, Syzygium aromaticum, Ferula foetida, Inula racemosa, Hemides musindicus, Rubia cordifolia, Glycyrrhizaglabra* and *Saussurealappa*) possessed marginal to excellent antifungal activity. Hexane (Hx) and methanol (MeOH) extracts of *C. zeylanicum*showed complete inhibition of *A. solani in vitro* at a dose of 3 ml/lit water. Formulation trials conducted in shade house using MeOH extract of *C. zeylanicum* at a dose of 2 ml/lit water were highly effective against *A. solani* infesting tomato plants. TLC, HPTLC and GC-MS analysis confirmed the presence of Eugenol, Cinnamaldehyde and 2H -1- Benzopyran -2- one in MeOH extract of *C. zeylanicum*. These secondary metabolites were isolated by preparative TLC to further confirm antifungal activity and probable structures by GC-MS. 2H-Benzopyran-2-one, a coumarin has been reported for the first time as an antifungal against *A. solani* in present study. An effective lab-scale formulation was developed and tested against *A. solani* (36).

The crude oils from roots of *Inula racemosa* Hook.f.and *Saussurea lappa* Clarke at four concentrations (from 0.625 to 5%) significantly reduced the leaf damage done by *Spodoteralitura* (Fabricius) larvae. The rate of feeding deterrence measured after treatment with oils of *I. racemosa* and *S. Lappa* at these concentrations ranged from 20 to 72% and 18 to 62%, respectively. The rate of mortality during larval and prepupal stages was greater than 50% at the 5% concentration. Pupation was adversely affected only at the highest concentration of both oils. Pupal weight was normal, while adult emergence was marginally affected by both oil treatments (37).

Mosquito Larvicidal Activity of Inula racemosa Hook. f.:

Qing et al isolated 11,13-dihydroisoalantolactone, macrophyllilactone E, 5-*α*-epoxyalantolactone and epoxyisoalantolactone from the ethanol roots extract of *I. racemosa*. Mosquito larvicidal activity of all these isolated compounds was evaluated against the

larvae of *Aedesalbopictus and Asian tiger* mosquitoes. The tested compound 11,13-dihydroisoalantolactone and macrophyllilactone E exhibited strong larvicidal activity against the early fourth-instar larvae of *A. albopictus*with LC50 values of 21.86 μgmL−1 and 18.65 μgmL−1 respectively, whereas 5-α-epoxyalantolactone and epoxyisoalantolactone also possessed larvicidal activity against the Asian tiger mosquitoes with LC50 values of 29.37 μgmL−1 and 35.13 μgmL−1 respectively **(38)**.

Conclusion

Microbial infections wheather in plants or in humans have posed a great challenge in front of us. The emergence of microbial resistance to the currently available agents necessitates the further research in the discovery of new safe and effective antimicrobial agents. The medicinal plants have shown a promising alternative for the treatment of infectious diseases. In the antimicrobial research, the vast majority of the new chemical entitties are natural or natural product- derived molecules . *Inula racemosa* has been used as anti-microbial agents since ages as it has several phytochmeicals which shows high anti-microbial activity both in humans and plants. Phytochemicals using as pesticides is the most safest and environment friendly method because they are non-toxic and biodegradable in nature.

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