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MINI REVIEW

Pseudomoniasis phytotherapy: a review on most important Iranian medicinal plants effective on *Pseudomonas aeruginosa*

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ABSTRACT

Background and Objectives: *Pseudomonas aeruginosa* is a Gram-negative, aerobic bacterium found in water and soil. It is a normal flora in skin and gastrointestinal tract of human beings. *P. aeruginosa* as an opportunistic pathogen involved in nosocomial infections having multiple pathogenic factors and shows high rate of resistance to different antibiotics. The aim of this study was to identify the most important native medicinal plants of Iran effective on *P. aeruginosa.*
Materials and Methods: All required information was obtained by searching keywords such as *P. aeruginosa*, medicinal plant extracts or essential oils in published articles in authentic scientific databases such as Science Direct, Wiley-Blackwell, Springer, Google scholar, Scientific Information Database (SID) and Magiran.
Results: According to the literature review, our results showed 12 different native medicinal plants were effective against *P. aeruginosa* in Iran including *Eucalyptus camadulensis, Marticaria chamomilla, Ferula gummosa Boiss, Lawsonia inermis, Ocimumgra tissimum, Allium sativum, Satureja hortensis L, Satureja bachtiarica Bunge, Satureja khuzestanica (Jamzad), Thymus daenensis Celak, Thymus carmanicus Jalals* and *Camellia sinensis.*
Conclusion: Phytochemical analysis has shown that bioactive compounds of medicinal plants with their antioxidant and antimicrobial properties can be good alternatives for the synthetic medicines in food and drug industry.

Keywords: Medicinal plants, *Pseudomonas aeruginosa*, Antimicrobial, Iran

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INTRODUCTION

Pseudomonas aeruginosa is a Gram-negative, aerobic bacterium found in water and soil. It is a normal flora of the skin and gastrointestinal tract of human beings (1, 2). This bacterium as an opportunistic pathogen is one of the most important microorganisms in nosocomial infections in immune-compro-

mised patients including patients with malignancies, cystic fibrosis and burns with multiple pathogenic factors and high rate of resistance to most of the antibiotics. The presence of glycocalyx in cellular membrane is responsible for easy binding of the bacterium to the host cell, biofilm formation and protection of bacteria against penetration of antimicrobial agents and phagocytic system (3).

In a previous study, *P. aeruginosa* has been isolated from nosocomial pneumonia (16%), nosocomial urinary tract infections (12%), post-operative wound infections (85%) and hospital blood infections (10%) which included 23% of total isolated bacteria from admitted patients (4). Selection of the appropriate treatment approach against *P. aeruginosa* is limited due to its resistance to common recommended antibiotics (5, 6).

Bacterial resistance to antibiotics is increasing which makes humans to apply effective antimicrobial agents with fewer side effects such as medicinal plants instead of medicines with less efficacy and greater side effects (7). Plants have different chemical compounds like secondary metabolites (8, 9) with many biochemical and bioactivity properties showing applications in various industries such as pharmaceutical, chemical, cosmetic and food industry (10-13). The aim of this study was to introduce the most important native medicinal plants of Iran being effective on *P. aeruginosa*.

MATERIALS AND METHODS

All required information was obtained by literature review using keywords including *P. aeruginosa*, medicinal plant extracts or essential oils of published articles in authentic scientific databases such as Science Direct, Wiley-Blackwell, Springer, Google scholar, Scientific Information Database (SID) and Magiran.

RESULTS

According to literature review, our results showed 12 different native medicinal plants were effective against *P. aeruginosa* in Iran including *Eucalyptus camadulensis, Marticaria chamomilla, Ferula gummosa Boiss, Lawsonia inermis, Ocimumgra tissimum, Allium sativum, Satureja hortensis L, Satureja bachtiarica Bunge, Satureja khuzestanica (Jamzad), Thymus daenensis Celak, Thymus carmanicus Jalals* and *Camellia sinensis*. Effective medicinal plants against *P. aeruginosa* are listed in Table 1.

DISCUSSION

Secondary compounds have attracted particular attention to the plants in recent years. Medicinal plants are good alternatives for synthetic preservatives in food and drug industry due to their antimicrobial compounds. *E. camadulensis* (Eucalyptus) leaves are rich in polyphenols and terpenoids and eucalyptol or cineole (26). Phytochemicals results showed that alfa and beta-pinenes are the main ingredients of *Ferula gummosa Boiss* (galbanum) (27) and *Lawsoniainermis* (Henna) containsmanitol, tanic acid, mucilage and galic acid but its most important ingredient is 2-Hydroxy-1,4-naphoquinone (Lawson) recognized as bioactive agent. *Ocimumgra tissimum* (basil) contains essential oils, tannins, glycosides, saponin, anthocyanin, eugenol, linalool, methyl cinnamate, camphor and thymol. Allicin is the major component of *Allium sativum* (28). Different species of *Satureja* (Savory) contain monoterpenes, phenolic compounds especially carvacrol, thymol and eugenol as well as some of the sesquiterpenes. The main phytochemical essential oils of aromatic plants are hydrocarbons, aldehydes, ketones, alcohols, phenols, ethers and esters with phenolic and terpenic sources. The presence of linalool, alpha-pinene, beta-pinene, borneol, carvone, limonene, carvacrol, p-cymene and terpinenein essential oils of understudy plants showed antimicrobial properties particularly (28). These compounds with high hydrophobic properties can separate lipids from bacterial cell wall and thereby increase the permeability of the membrane which leads to ion expelling and electron imbalance and eventually cell death. The researchers demonstrated that plant species used in popular medicine are promising resources for antimicrobial treatments (13, 14, 29, 30).

CONCLUSION

Phytochemical analysis has shown that bioactive compounds of medicinal plants with their antioxidant and antimicrobial properties are good substitutions for synthetic drugs in food and drug industry.

Table 1. List of effective Iranian native medicinal plants against *P. aeruginosa* (PA)

Scientific name	Plant Family	Persian name	Discussion
Eucalyptus camadulensis	Myrtaceae	Eucalyptus	Minimum inhibitory concentration (MIC) of alcoholic and aqueous extracts were 3.3 mg/ml and 17.5 mg/l. Increasing concentration of the extract prevented growth more effectively in comparison with control group (13).
Marticaria chamomilla	Asteraceae	Babooneh	At a concentration of 0.5 mg/ml of essential oil the growth of PA was significantly lower than the positive control (14).
Ferula gummosa Boiss (Galbanum)	Umlelliferae	Baryjeh	MIC of methanol and ethanol extracts was 1.25×10^4 and 625×10^3 µg/ml, respectively (15).
Lawsonia inermis	Lythraceae	Henna	MIC of aqueous and ethanol extracts was 10 and 3.5 mg/ml, respectively (16).
Ocimum gratissimum (Basil)	Laminaceae	Reyhan	The inhibition zone diameter of ethanol extract with 100 and 200 mg/ml concentration were 8 and 12 mm (in diameter) but for aqueous extract (with the same concentration), they were 4 and 9 mm, respectively (17).
Allium sativum	Liliaceae	Sir	MIC of the extract at 220 µg/ml conc. had a 16 mm growth inhibition zone (in diameter) (18). In another study MIC and MBC of Allicin were 2.38 and 4.77 mg/ml, respectively (25).
Satureja hortensis L	Labiatae	Marzeh	Growth inhibition zone in disk diffusion method was 19.88 mm (in diameter) (19).
Satureja bachtiarica Bunge	Labiatae	Marzeh bakhtyari	Growth inhibition zone in disk diffusion method was 22.22 mm (in diameter) (19).
Satureja khuzestanica (Jamzad)	Labiatae	Marzeh khoozestani	Growth inhibition zone in disk diffusion method was 18.33 mm (in diameter) (19).
Thymus daenensis Celak Thymus carmanicus	Laminaceae	Avishan denaee	Growth inhibition zone in disk diffusion method was 21.88 mm (in diameter) (19).
Jalals Camellia sinensis	Laminaceae	Avishan kermani	Growth inhibition zone in disk diffusion method was 20.66 mm (in diameter) (19).
	Theaceae	Katchin (Chaysabz)	MIC at 0.01 dilution was 7.24 µg/ml (24).

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