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Phytochemical constituents and antibacterial efficacy of the flowers of *Peltophorum pterocarpum* (DC.) Baker ex Heyne

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ABSTRACT

Objective: To investigate the preliminary phytochemistry and antibacterial activity of the flower extract of *Peltophorum pterocarpum*. **Methods:** Phytochemical analysis was done by using the standard methods given by Harbone. The methanolic flower extract were tested against *Escherichia coli*, *Klebsiella pneumonia*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Bacillus cereus*, *Salmonella typhi*, *Serratia marsecens*, *Acinetobacter baumannii*, *Enterobacter* sp., *Proteus mirabilis*, *Enterococcus faecalis* and *Streptococcus pyogenes* by the agar disc diffusion method. **Results:** Preliminary phytochemical screening of flower extract showed the presence of phenolic compounds, flavonoids, saponins, steroids, tannins, xanthoproteins, carboxylic acids, coumarins and carbohydrates. The flower extract of *Peltophorum pterocarpum* showed significant activity against four gram positive (*Staphylococcus aureus*, *Bacillus cereus*, *Enterococcus faecalis* and *Streptococcus pyogenes*) and three gram negative bacteria (*Proteus mirabilis*, *Acinetobacter baumannii* and *Serratia marsecens*), out of 12 pathogenic bacteria studied. **Conclusions:** The findings of the present study confirm the presence of significant antibacterial activity against human pathogens in the flowers of *Peltophorum pterocarpum*.

1. Introduction

Since time immemorial plants have been used as a medicine among the indigenous community of India, and posses a vast array of bioactive compounds[1-5]. The bioactive compounds obtained from medicinal plants have been used to treat various ailments caused by microorganisms[6-10]. The most important of these bioactive principles are alkaloids, phenolic compounds, flavanoids and tannins that may be evolved in plants as self defense against pests and pathogens[11-15]. Nature selects such type of plants and these plants are normally free from pest as well as pathogens[16]. Several members of *Angiosperms surviving* in this present era have such compounds helping the plant to establish itself. It is very difficult to see any diseased or damaged leaves in such plants, especially trees like, *Polyalthia longifolia*, *Albizia lebbeck*, *Albizia amara*, *Cassia* sp., etc. One such tree is *Peltophorum pterocarpum* (DC.) Baker ex Heyne (*P. pterocarpum*)[17].

P. pterocarpum, belongs to the family Caesalpiniaceae, is a native species of Sri Lanka, the Andamans, the Malay Peninsula and North Australia, commonly called copper pod or yellow flame tree. It is a very attractive tree with its spreading crown of many branches consisting of feathery mimosa like leaves and abundance of bright yellow blooms and gives wonderful sight when the copper-red seedpods cover the tree in profusion. Thus the tree is having high ornamental value and planted as avenue trees. Moreover, the leaves of the trees are used to feed the goats and the dead branches are collected by village people to use as fire wood. In terms of biodiversity it serves as a good nectar source for Hymenopteran insects including honey bees, bumble bees and several economically important vasps[18, 19]. Apart from these it is also having potent medicinal value. Traditionally the bark of the tree is used to treat wounds among the Paliyar tribe[20] and dentifrice among the indigenous inhabitants of Tamilnadu for oral healthcare practices[21]. Orang Asli tribe of Kampung Bawong, Malaysia is using the powdered bark of this plant to treat psoriasis[22]. Recent studies revealed that the plant bark and leaves has antimicrobial[23-28], antioxidant[29], antifungal[30-32], apoptotic[33] and haematological[34]. Past studies revealed that so far there is no study pertaining

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phytochemical constituents and antibacterial activity of the flowers of *P. pterocarpum*. As this tree blooms twice in a year, the floral resources wasted unutilized. Hence it is imperative to evaluate the phytochemical constituents and antibacterial efficacy of *P. pterocarpum*, commonly known as Perungondrai in Tamil.

2. Materials and methods

2.1. Collection and identification of plant specimen

The flowers of *P. pterocarpum* was collected from the arboretum of Botany Department, Nesamony Memorial Christian College (NMCC), Marthandam, Tamilnadu, India and authenticated by Dr. K. Paulraj, Head, Department of Botany and Research Centre, NMCC, Marthandam, then a voucher specimen of the plant was deposited in the herbarium of the Botany department, NMCC, Marthandam for further studies.

2.2. Preparation of plant extracts

The air-dried and powdered plant materials (100 g of each) were extracted with 250 mL of methanol by using a Soxhlet apparatus for 72 h at a temperature not exceeding the boiling point of the solvent. The extract was concentrated under reduced pressure using rotary evaporator and freeze dried to give the crude dried extract. The extract was dissolved in 0.1% dimethylsulphoxide (DMSO) for antibacterial studies.

For phytochemical screening, the shade dried and powdered flowers were successively extracted with acetone, benzene, chloroform, water, ethanol and petroleum ether by cool extraction method for 24 hours. The extract was concentrated by using rotary evaporator and used for phytochemical screening.

2.3. Preliminary phytochemical screening

Phytochemical screening of plant extract was carried out qualitatively for the presence of alkaloids, phenolic compounds, flavonoids, saponins, aminoacids, quinines, steroids, tannins, xanthoproteins, carboxylic acids, coumarins, and carbohydrates by using the standard methods given by Harborne[35].

2.4. Antibacterial assay

Escherichia coli, Klebsiella pneumonia, Pseudomonas aeruginosa, Staphylococcus aureus, Bacillus cereus, Salmonella typhi, Serratia marsecens, Acinetobacter baumannii, Enterobacter sp., *Proteus mirabilis, Enterococcus faecalis* and *Streptococcus pyogenes* were used for the present study. Stock cultures were maintained at 4 ℃ on slants of nutrient agar. Active cultures for experiments were prepared by transferring a loopful of colonies from the stock culture to peptone water and incubated for 4h at 37 ℃.

Antibacterial activity was determined by agar disc diffusion method. Standard suspension of bacteria was inoculated on the surface of Muller-Hinton (Himedia) agar plates. Sterilized filter paper discs (5 mm) containing 50 μL of each extract were arranged on the surface of the inoculated plates and incubated at 37 ℃ for 124h. Along with this 30 μg Amikacin disc (Himedia standard) was studied for antimicrobial activity as a positive control whereas the solvent used (DMSO) for preparing extract was used as a negative control. At the end of incubation, inhibition zones formed around the disc were measured with Himedia zone scale.

3. Results

3.1 Phytochemicals

Preliminary phytochemical screening of the present study revealed the presence of phenolic compounds, flavonoids, saponins, steroids, tannins, xanthoproteins, carboxylic acids, coumarins and carbohydrates, while it gave the negative results to alkaloids, quinone and proteins. A total of 6 plant extracts to test the availability of 12 biochemical compounds (6 × 12 = 72), only 30 gave positive results and the remaining 42 gave negative results. Acetone and benzene extract showed the presence of 6 compounds each, followed by chloroform, petroleum ether and water had 5 compounds each, while methanol showed the presence of 3 compounds (phenolic compound, tannins and steroids). Based on the preliminary phytochemical analysis methanolic extract showed the presence of three important bioactive compounds, namely phenols, tannins and steroids, hence methanolic flower extract was selected to study the pathogenic activity against 12 human pathogens.

3.2. Antibacterial activity

The antibacterial activity of the flower extracts of *P. pterocarpum* are presented in table 1. Of the twelve pathogens studied against the flower extracts, seven were susceptible (*Staphylococcus aureus*, *Proteus mirabilis*, *Acinetobacter baumannii*, *Serratia marsecens*, *Bacillus cereus*, *Enterococcus faecalis* and *Streptococcus pyogenes*), which includes four gram positive (*Staphylococcus aureus*, *Bacillus cereus*, *Enterococcus faecalis* and *Streptococcus pyogenes*) and three gram negative bacteria (*Proteus mirabilis*, *Acinetobacter baumannii* and *Serratia marsecens*), the remaining five organisms are resistant (*Escherichia coli*, *Klebsiella pneumonia*, *Enterobacter* sp., *Salmonella typhi* and *Pseudomonas aeruginosa*) to the extracts.

Table 1
Antibacterial activity of the flower extracts of *P. pterocarpum* against human pathogens.

Microorganism	Zone of inhibition (mm)	
	Flower extract(50 μL)	Amikacin(30 μL)
Escherichia coli	–	25
Klebsiella pneumonia	–	21
Pseudomonas aeruginosa	12	22
Staphylococcus aureus	10	16
Bacillus cereus	10	9
Salmonella typhi	–	14
Serratia marsecens	9	21
Acinetobacter baumannii	–	28
Enterobacter sp.	10	17
Proteus mirabilis	11	16
Enterococcus faecalis	8	14
Streptococcus pyogenes	–	22

The methanolic flower extract showed the maximum zone of inhibition against the gram positive pathogen Staphylococcus aureus (12 mm), followed by Proteus mirabilis (11mm), Enterococcus faecalis (8 mm) , Enterobacter sp. and Bacillus cereus had 10 mm zone each, whereas Serratia marsecens and Streptococcus pyogenes had 9 and 8mm zone respectively.

4. Discussion

Plants are important source of functional components for the development of new chemotherapeutic agents. Phytochemical investigation of the methanolic flower extracts of *P. pterocarpum* revealed the presence of various phytochemicals such as phenolic compounds, flavonoids, saponins, steroids, tannins, xanthoproteins, carboxylic acids, coumarins and carbohydrates. As phytochemicals often play an important role in plant defence against prey, microorganism, stress as well as interspecies protections, these plant components have been used as drugs for millennia. Hence, phytochemicals screening serves as the initial step in predicting the types of potential active compounds from plants[36].

It has been reported by several workers that methanol was the most effective solvent for flower extraction than other solvents[20, 37]. Based on the previous reports and phytochemical observations, in the present study we have used methanol for the extraction of bioactive compounds from the flower petals of *P. pterocarpum* and obtained positive results against seven human pathogens. This antibacterial activity may be the indicative of the presence of some metabolic toxins or broad-spectrum antibiotic compounds.

Past literature on antimicrobial studies revealed that plant extracts were most effective against gram positive than gram negative microorganisms[38-45]. The present findings corroborate the previous reports that the flower extracts of *P. pterocarpum* showed the antibacterial activity (4/3) against four gram positive and three gram negative pathogens.

Several species of *Peltophorum* have been proved to have high degree of antimicrobial and antioxidant activity, due to the presence of different kinds of bioactive compounds. The methanolic extract of the leaves of *Peltophorum vogelianum* (Caesalpiniaceae) afforded a new phytoconstituent, 2-methoxy-4,5-dihydroxy-1(7,8-dihydroxyethylene)-8-β-D-glucuropyranoside named as peltophorumyl-β-D-glucuropyranoside showed significant antimicrobial activity[46]. A new C-glucoside benzoic acid derivative, 3α C-glucopyranosil-4,5-dihydroxy-2-methoxy-benzoic acid isolated from the leaves of *Peltophorum dubium* Taub (Leguminosae) showed antioxidant activity in the assay and the auto-oxidation of β-carotene in a linolenic acid suspension method[47]. Duraipandian *et al.*[20] observed the antibacterial activity of methanolic flower extract of *P. pterocarpum* against *Bacillus subtilis*, *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Enterococcus faecalis*, *Eschersichia coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumonia*, *Eruvinia* sp., *Candida albicans* and *Proteus vulgaris*. In addition to the previous observation, the present study revealed and supplemented the antibacterial activity against the bacterial pathogens namely, *Proteus mirabilis*, *Aceinetobacter* sp., *Enterobacter* sp., *Serratia marsecens*, *Salmonella typhi*, *Bacillus cereus* and *Sterptococcus pyogenes*. However, in the case of *Pseudomonas aeruginosa*, earlier study revealed positive result, while it gave negative results in the present study, which needs to be evaluated.

Conflict of interest statement

We declare that we have no conflict of interest.

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References

[1] Balakumar S, Rajan S, Thirunalasundari T, Jeeva S. Antifungal activity of *Aegle marmelos* (L.) Correa (Rutaceae) leaf extract on dermatophytes. *Asian Pac J Trop Biomed* 2011; **1**(4): 309-312.

[2] Jeeva S, Kiruba S, Mishra BP, Kingston C, Venugopal N, Laloo RC. Importance of weeds as traditional medicine in Kanyakumari district, southern Western Ghats. *J Swamy Bot Club* 2005; **22** (3 & 4): 71-76.

[3] Jeeva S, Kiruba S, Mishra BP, Venugopal N, Das SSM, Sukumaran S, et al. Weeds of Kanyakumari district and their value in rural life. *Indian J Trad Knowl* 2006; **5** (4): 501-509.

[4] Jeeva S, Kiruba S, Mishra BP, Venugopal N, Regini GS, Das SSM,et al. Diversity of medicinally important plant species under coconut plantation in the coastal region of Cape Comorin. *Flora Fauna* 2005; **11**(2): 226-230.

[5] Premkumar G, Sankaranarayanan R, Jeeva S, Rajarathinam K. *Asian Pac J Trop Biomed* 2011; **1**(3): 169-172.

[6] Pugazharasi G, Meenakshi SA, Ramesh Kannan N, Bastin Churchill M, Natarajan E. Screening of antimicrobial activity of Phyllanthus maderaspatensis L. *J Basic Applied Bio* 2009; **3**(3&4): 43-49.

[7] Suresh Kumar P. Anti-fungal activity of *Leptadenia reticulata* in rat animal model *in vivo*. *J Basic Appl Bio* 2008; **2**(1): 9-13.

[8] Hasan MF, Khan A, Rahman M, Sikdar B. Determination of antibacterial and antifungal activities of *Polygonum hydropepper* L. root extract. *J Basic Applied Bio* 2009; **3**(1&2): 6-10.

[9] Jeeshna MV, Manorama S, Paulsamy S. Antimicrobial property of the medicinal shrub, *Glycosmis pentaphylla*. *J Basic Applied Bio* 2009; **3**(1&2): 25-27.

[10]Anpin Raja RD, Prakash JW, Jeeva S. Antibacterial activity of some medicinal plants used by Kani tribe, southern Western Ghats, Tamilnadu, India. In: Trivedi PC. (ed.) *Ethnic tribes and medicinal plans*. Jaipur: Pointer Publishers; 2010,p.28-45.

[11]Paulraj K, Irudayaraj V, Johnson M, Patric Raja D. Phytochemical and anti-bacterial activity of epidermal glands extract of *Christella parasitica* (L.) H. Lev. *Asian Pac J Trop Biomed* 2011; **1**(1): 8-11.

[12]Rajan S, Jeevagangai TJ. Studies on the antibacterial activity of *Aegle marmelos* -fruit pulp and its preliminary phytochemistry. *J Basic Applied Bio* 2009; **3**(1&2): 76-81.

[13]Suresh SN, Nagarajan N. Preliminary phytochemical and antimicrobial activity analysis of *Begonia malabarica* Lam. *J Basic Applied Bio* 2009; 3(1&2): 59-61.

[14]Irudayaraj V, Janaky M, Johnson M, Selvan N. Preliminary

phytochemical and antimicrobial studies on a spike-moss Selaginella inaequalifolia (hook. & grev.) Spring. *Asian Pac J Trop Med* 2010; **3**(12): 957-960.

[15]Madhumitha G, Saral AM. Preliminary phytochemical analysis, antibacterial, antifungal and anticandidal activities of successive extracts of *Crossandra infundibuliformis*. *Asian Pac J Trop Med* 2011; **4**(3): 192-195.

[16]Kiruba S, Mishra BP, Israel Stalin S, Jeeva S, Sam Manohar Das S. Traditional pest management practices in Kanyakumari district, southern peninsular India. *Indian J Trad Knowl* 2006; **5**(1): 71-74.

[17]Kiruba S, Jeeva S, Kanagappan M, Israel Stalin S, Sam Manohar Das S. Ethnic storage strategies adopted by farmers of Tirunelveli district of Tamilnadu, southern peninsular India. *J Agric Technol* 2008; **4**(1): 1-10.

[18]Kiruba S, Ruba Gnana Solomon S, Israel Stalin S, Jeeva S, Sam Manohar Das S. Commonly used medicinal plants of the coastal belts of Kanyakumari district and their role in conservation of butterfly diversity. In: Vikram Reddy R. (eds.) *Wildlife Biodiversity and Conservation*. New Delhi:, Daya Publishing House;2008.

[19]Kiruba S, Ruba Gnana Solomon S, Israel Stalin S, Jeeva S, Sukumaran S, Prakash JW, et al. Diversity of larval host plants of Kanyakumari district. *J Basic & Appl Biol* 2008; **2**(2): 16-30.

[20]Duraipandian V, Ayyappan M, Ignacimuthu S. Antimicrobial activity of some ethnomedicinal plants used by Paliyar tribe from Tamilnadu, India. *BMC Complementary & Altern Med* 2006; **6**: 35.

[21]Ganesan S. Taditional oral care medicinal plant survey of Tamilnadu. *Nat Prod Rad* 2008; **7**(2): 166-172.

[22]Samuel AJSJ, Kalusalingam A, Chellappan DK, Gopinath R, Radhamani S, Husain H, et al. Ethnomedical survey of plants used by the Orang Asli in Kampung Bawong, Perak, West Malaysia. *J Ethnobiol & Ethnomed* 2010; **6**:5.

[23]Voravuthikunchai S, Lortheeranuwat A, Jeju W, Srinrak T, Phongpacicht S, Supawita T. Effective medicinal plants against ethnohaemorrhagic *Escherichia coli* O157:H7. *J Ethnopharmacol* 2004; **94**: 49-54.

[24]Voravuthikunchai S, Piyawan S, Surasuk L. Medicinal plant extracts as anti-*Escherichia coli* O157:H7 agents and their effect on bacterial cell aggregation. *J Food Prot* 2006; **69**(10): 2236-2341.

[25]Voravuthikunchai S, Khla S. Antibacterial activity of crude extract of Thai medicinal plants against clinical isolates of methicillin - resistant Staphylococcus aureus. *Songklanakarin J Sci Technol* 2005; **27**(2): 525-534.

[26]Limsuwan S, Vanmanee S, Voravuthikunchai S. Effect of Thai medicinal plant extracts on cell aggregation of *Escherichia coli* O157:H7. *Songklanakarin J Sci Technol* 2005; **27**(2): 545-554.

[27]Ravikumar R, Rathinam KMS, Prabakar G. Anti bacterial activity of selected plants of the family Caesalpiniaceae. *J Ecobiol* 2007; **20**(4): 351-354.

[28]Ravikumar R, Rathinam KMS. Antibacterial activity of hexane and acetone extracts of *Peltophorum pterocarpum* Calvillea racemosa and *Bauhinia purpurea*. *International J Chem Sci* 2009; **7**(3): 1751-1756.

[29]Ling LT, Radhakrishnan AK, Subramanian T, Cheng HM, Palanisamy DP. Assessment of antioxidant capacity and cytotoxicity of selected Malaysian plants. *Molecules* 2010; **15**: 2139-2151.

[30]Sathish S, Mohana DC, Raghavendra MP, Raveesha KA. Antifungal activity of some plant extracts against important seed borne pathogens of Aspergillus sps. *J Agric Technol* 2007; **3**(1): 109-119.

[31]Sathish S, Raghavendra MP, Raveesha KA. Antifungal potentiality of some plant extracts against *Fusarium* sp. *Arch Phytopathol Plant Prot* 2009; **42**(7): 618-625.

[32]Lam SK, Tzi Bun NG. First report of an antifungal amidase from Peltophorum pterocarpum. *Biomed Chromatogr* 2009; **24**(5): 458-464.

[33]Jabbir MSM, Husain AM, Afsar TS, Kumar SS. Study on the Apoptotic properties of methanolic extracts of *Peltophorum pterocarpum*, *Cassia auriculata*, *Cassia alata* and *Lamprachaenium microcephalum*. *Biomed Pharmacol J* 2009; **2**(2): 381-385.

[34]Ravikumar R, Rathinam KMS. Toxic effects of *Peltophorum pterocarpum* on haematological and biochemical parameters of rats. *Int J Chem Sci* 2009; **7**(2): 1136-1142.

[35]Harbone JB. *Phytochemical methods- a guide to modern techniques of plant analysis*. London: Chapman and Hall;1998.

[36]Chew YL, Chan EWL, Tan PL, Lim YY, Stanslas J, Goh JK. Assessment of phytochemical content, polyphenolic composition, antioxidant and antibacterial activities of Leguminosae medicinal plants in Peninsular Malaysia. *BMC Complementary Altern Med* 2011; **11**:12.

[37]Saravanakumar A, Venkateshwaran K, Vanitha J, Ganesh M, Vasudevan M, Sivakumar T. Evaluation of antibacterial activity, phenol and flavonoid contents of *Thespesia populnea* flower extracts. *Pakistan J Pharm Sci* 2009; **22**(3): 282-286.

[38]Chouhan HS, Singh SK. Antibacterial activity of seed and flower parts of *Crotalaria juncea* Linn. *American-Eurasian J Sci Res* 2010; **5**(3): 212-215.

[39]Maneemegalai S, Monika P. Determination of activity of leaf and flower extracts of *Millingtonia hortensis* L. against primary and opportunistic pathogens. *J Herbal Med Toxicol* 2010; **4**(2): 127-132.

[40]Raju B, Vijaya C, Ramu A. Evaluation of cardiotonic activity of *Peltophorum pterocarpum*. *Inter J Phytopharmacol* 2011; **2**(1): 1-6.

[41]Patel DK, Kumar R, Prasad SK, Sairam K, Hemalatha S. Antidiabetic and *in vitro* antioxidant potential of *Hybanthus enneaspermus* (Linn) F. Muell in streptozotocin-induced diabetic rats. *Asian Pac J Trop Biomed* 2011; **1**(4): 316-322.

[42]Habbal O, Hasson SS, El-Hag AH, Al-Mahrooqi Z, Al-Hashmi N, Al-Bimani Z, et al. Antibacterial activity of *Lawsonia inermis* Linn (Henna) against *Pseudomonas aeruginosa*. *Asian Pac J Trop Biomed* 2011; **1**(3): 173-176.

[43]Manivannan K, devi GK, Anantharaman P, Balasubramanian T. Antimicrobial potential of selected brown seaweeds from Vedalai coastal waters, Gulf of Mannar. *Asian Pac J Trop Biomed* 2011; **1**(2): 114-120.

[44]Sasidharan S, Prema B, Latha LY. Antimicrobial drug resistance of *Staphylococcus aureus* in dairy products. *Asian Pac J Trop Biomed* 2011; **1**(2): 130-132.

[45]Paul KR, Irudayaraj V, Johnson M, Patric DR. Phytochemical and anti-bacterial activity of epidermal glands extract of *Christella parasitica* (L.) H. Lev. *Asian Pac J Trop Biomed* 2011; **1**(1): 8-11.

[46]Parveen M, Ghalib RM, Khanam Z, Mehdi SH, Ali M. A novel antimicrobial agent from the leaves of *Peltophorum vogelianum* (Benth.) *Nat Prod Res* 2010; **24**(13): 1268-1273.

[47]Bahia MV, David JM, Rezende LC, Maria Guedes LS, David JP. A C-glucoside benzoic acid derivative from the leaves of Peltophorum dubium. *Phytochem Lett* 2010; **3**(3): 168-170.