Screening of Antimicrobial Properties of *Jasminum sambac* Linn. Leaf Extracts against Dental Pathogens

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ABSTRACT
In present study, antimicrobial efficacy of *Jasminum sambac* leaf extracts was evaluated against six bacteria (*Staphylococcus aureus*, *Streptococcus mutans*, *S. pyogenes*, *S. sobrinus*, *S. sanguinis* and *Lactobacillus acidophilus*) and one fungi (*Candida albicans*) causing dental infections. Results showed that methanol extract was more efficient in comparison to other extracts. The zone of inhibition ranged between 12.3±0.57-17.3±0.57 mm examined at 200 mg mL\(^{-1}\), respectively. Minimum inhibitory concentration were recorded for methanol extract at 3.12-25 mg mL\(^{-1}\). Phytochemical analysis of extracts showed the presence of alkaloids, flavonoids, glycosides, steroids, tannins, terpenoids and saponins. The results conclude the traditional uses of *J. sambac* in treatment of dental diseases.

Key words: Antimicrobial activity, dental pathogens, *Jasminum sambac*, minimum inhibitory concentration

INTRODUCTION
Oral microflora is a complex system comprises variety of bacterial and fungal organisms involved specifically/non-specifically in mutualistic relationship with host by preventing pathogenic species. About 700 microbial species are identified from oral microbiome (Palmer et al., 2008). Bacterial involvement can cause dental caries or cavities and periodontal diseases, simply pathological inflammatory condition of gum and periodontal tissues. Several bacteria are responsible for dental caries and periodontal infections including *Lactobacillus acidophilus*, *Streptococcus mutans*, *S. sobrinus*, *Actinomyces* spp., *Nocardia* spp., *Camphylobacter*, *Fusobacterium*, *Haemophilus*, *Prevotella*, *Porphyromonas* and *Veillonella* (Kononen et al., 1994; Marsh, 1992; Schupbach et al., 1995). If we focus on the microbial role, they ferment many sugars and resulting products are utilized by dental plaque bacteria (Prasad et al., 2008). Due to production of high level of lactic acid causing fermentation of dietary sugars and resistant to the adverse effect of low pH (Walsh, 2006).

*Jasminum sambac* Linn. (Oleaceae), commonly known as Chameli, is a shrub, about 1.5-2.0 m long, bearing small white flower. It is commonly distributed in all over tropical region of India. Its various parts are used in preparation of medicine, perfumes and aromatizing products (Abdoul-Latif et al., 2010). Other medicinal applications of *J. sambac* have been reported in curing insanity, skin diseases, ulcers, sight weakness, leprosy and suppression of puerperal lactation (Mittal et al., 2011).
Currently, herbal medicines have received greater attention because of their multiplicity of curing diseases, safety and being well tolerated remedies when compared with the conventional drugs. Herbs had been priced for their medicinal, flavouring and aromatic abilities for long time (Srivastava et al., 2013). Present days, phytoconstituents have been extensively investigated as a source of medicinal agents (Krishnaraju et al., 2005). Therefore, phytochemicals with adequate antimicrobial efficiency can be used for the treatment of numerous infectious diseases (Balandrin et al., 1985). The present study was aimed to investigate antimicrobial properties of J. sambac against selected pathogens causing dental infections.

**MATERIALS AND METHODS**

**Plant material:** The leaves of J. sambac was collected from Haridwar, Uttarakhand and authenticated at Botanical Survey of India (BSI), Deharadun. Leaves were washed in fresh running water, dried under shade at room temperature, crushed by using pestle and mortar and powdered in an electric grinder.

**Preparation of extract:** Plant extracts were prepared by immersing 200 g of powdered seeds in 600 mL of four different solvents including Petroleum Ether (PET), Acetone (ACE), methanol (MeOH) and aqueous (H2O) loaded in Soxhlet assembly and extracted for 72 h through successive method (Ahmad et al., 1998). Plant extracts were filtered through Whatman No. 1 filter paper and crude extracts obtained by removing solvent in vacuum evaporator at 30°C. Residues were stored at 4°C until further use. Extracts were dissolved in dimethylsulfoxide (DMSO) to a final concentration of 200 mg mL−1 for agar well diffusion method. The yield of PET extract was 5.1 g, ACE extract 6.5 g, MeOH extract 8.7 g and H2O extract 9.4 g, respectively.

**Test microorganisms:** The pathogenic organisms were selected for the study were Staphylococcus aureus (MTCC 1144), Streptococcus mutans (MTCC 890), S. sanguinis (ATCC 10556), S. sobrinus (ATCC 33478), S. pyogenes (MTCC 442), Lactobacillus acidophilus (MTCC 10307) and Candida albicans (MTCC 227) procured from IMTECH, Chandigarh and NCL, Pune.

**Antimicrobial activity:** Antibacterial activity of different extracts was determined by agar well-diffusion method (Ahmad et al., 1998). In vitro antibacterial activity was screened by using Mueller-Hinton Agar (MHA) medium No. 173 (Hi media Pvt. Ltd., Mumbai, India). The 0.1 mL of 12-16 h incubated cultures of bacterial species were mixed in molten medium and poured in pre-sterilized petri plates. Plates were allowed to solidify for 5-10 min. A cork borer (6 mm diameter) used to punch wells in medium and filled with extracts of 45 μL of 200 mg mL−1 final concentration of extracts. The DMSO was used as negative control. Efficacies of extracts against pathogens were compared with broad spectrum antibiotic Ofloxacin (positive control). Ofloxacin was dissolved in double distilled water. Plates were incubated at 37°C for 24 h in BOD incubator. At the end of incubation, inhibition zones formed around the well were measured with transparent ruler in millimetre. Each sample was assayed in triplicate and mean values were observed. The antibacterial activity was interpreted from size of diameter of zone of inhibition measured to the nearest millimetre (mm) as observed from clear zones surrounding the wells.

**Determination of Minimum Inhibitory Concentrations (MICs):** Two-fold serial dilution method (Aboaba et al., 2006) was used to determine the Minimum Inhibitory Concentrations
Fig. 1: Minimum inhibitory concentrations of methanol extract of *Jasminum sambac*. The inhibition is noted at A: 3.12 mg mL\(^{-1}\) against *S. aureus* B: 6.12 mg mL\(^{-1}\) against *S. sanguinis* and *S. sobrinus*, C: 12.5 mg mL\(^{-1}\) against *Streptococcus mutans* and *Lactobacillus acidophilus* and D: 25 mg mL\(^{-1}\) against *C. albicans* (MICs). The MeOH extract was diluted double fold (2:2) with nutrient broth in a series of six test tubes. Concentration of 50, 25, 12.5, 6.25, 3.12 and 1.56 mg mL\(^{-1}\) of crude MeOH extract were prepared separately and dissolved in 1 mL of DMSO. An aliquot of 1 mL of microorganism suspension (1.5×10\(^6\)) was inoculated into each tube (Fig. 1). Control tubes were inoculated with same quantity of sterile distilled water. All tubes were incubated at 37°C for 24 h. The lowest concentration that did not permit any visible growth when compared with control was considered as the minimum inhibitory concentration. The contents of all tubes that showed no visible growth were cultured on MHA medium incubated at 37°C for 24 h.

**Phytochemical screening:** The phytochemical analysis of plant extracts were carried out by using standard qualitative methods for identification of various classes of active phytochemicals (Evans, 1996; Scalbert, 1991).

**Test for alkaloids:**
- Test solution was acidified with acetic acid and a drop of Mayer’s reagent was added. A white precipitate indicated the presence of alkaloids
- The test solution gave brown precipitate with the Dragendorff’s reagent. The presence of brown precipitate showed positive test while absence of precipitate was negative

**Test for flavonoids:**
- On addition of conc. HCl in MeOH extract of material, a red colour appeared which indicated the presence of flavonoids
- Ethanolic solution of test material was added with small piece of magnesium ribbon, followed by drop wise addition of conc. HCl and change in colour noted. The colour was changed orange to red showed positive flavonoids test
**Test for glycosides:** The extract was filtered and sugar was removed by fermentation with baker’s yeast. The acid was removed by precipitation with Ba (OH)$_2$. The remaining extract contained the glycosides. The hydrolysis of the solution was done with conc. H$_2$SO$_4$ and after the hydrolysis the presence of sugar was determined with the help of Fehling’s solution.

**Test for steroids:** The extract was mixed with 3 mL CHCl$_3$ and 2 mL conc. H$_2$SO$_4$ was poured from the side of the test tube and the colour of the ring at the junction of two layers was noted. A red colour showed the presence of steroids.

**Test for tannins:** Extract was added in 1% ferric chloride and the colour was observed. Bluish black colour appeared, which disappeared on addition of dilute H$_2$SO$_4$ follow a yellow brown precipitate showed the presence of tannins.

**Test for saponins:** Extracts (0.5 mg) were boiled with water (10 mL) for 2 min in a test tube and cooled. The mixture was shaken vigorously and left for 2-3 min. Formation of 1 cm layer of foam indicates the presence of saponins.

**RESULTS**

Dental infections are one of the most common disease globally. The results showed that *J. sambac* possess better antimicrobial properties against selected microorganisms (Table 1). The MeOH extract showed the maximum antimicrobial activity against tested strains in comparison to other extracts followed by PET, ACE and H$_2$O extract. The best activity of MeOH extract was noted against *S. pyogenes* (17.3±0.28 mm), *S. sanguinis* (17.3±0.57 mm) and *L. acidophilus* (17.3±0.57 mm) and moderately active against *S. sobrinus* (16.6±0.28 mm), *S. mutans* (15.6±0.57 mm) and *C. albicans* (12.3±0.57 mm), respectively. The activity of reference drug (ofloxacin) were higher in comparison to tested crude extracts at similar concentration.

The MICs values for MeOH extract were ranged at 3.12- 25 mg mL$^{-1}$ (Fig. 1). *Jasminum sambac* presented similar MICs against *S. sanguinis* and *S. sobrinus* at 6.12 mg mL$^{-1}$, respectively. Moreover, MeOH extract of this plant manifested a better MIC against *S. aureus* at 3.25 mg mL$^{-1}$ and least MIC against *C. albicans* at 25 mg mL$^{-1}$.

The phytochemical analysis of plant extract showed positive tests for all performed phytochemical tests. It disclosed the presence of alkaloids, flavonoids, glycosides, steroids, tannins, terpenoids and saponins which might be accountable for its antimicrobial potential (Table 2).

| Microorganisms     | PET       | ACE       | MeOH      | H$_2$O     | Reference drug (Ofloxacin) |
|--------------------|-----------|-----------|-----------|------------|---------------------------|
| *L. acidophilus*   | 10.3±0.28 | 13.3±0.28 | 16.3±0.76 | 14.3±0.57  | 34.3±0.57                 |
| *S. aureus*        | 10.3±0.57 | 11.3±0.28 | 15.0±0.50 | 14.6±0.57  | 33.3±0.28                 |
| *S. mutans*        | 10.0±0.50 | 12.3±0.57 | 14.3±0.57 | 14.6±0.57  | 35.3±0.28                 |
| *S. pyogenes*      | 10.6±0.28 | 12.3±0.28 | 16.3±0.76 | 15.6±0.28  | 35.0±0.50                 |
| *S. sanguinis*     | 11.6±0.28 | 13.3±0.57 | 16.3±0.57 | 15.3±0.28  | 33.6±0.28                 |
| *S. sobrinus*      | 10.3±0.28 | 12.6±0.28 | 16.6±0.28 | 16.0±0.50  | 32.6±0.28                 |
| *Candida albicans* | 8.6±0.28  | 11.0±0.50 | 12.3±0.57 | 12.0±0.50  | 27.0±0.50                 |

*Values are mean of three replicates expressed as means and standard error of means, cork borer diameter: 6 mm, PET: Petroleum ether, ACE: Acetone, MeOH: Methanol
Table 2: Phytochemical screening of Jasminum sambac leaf crude extracts

| Phytoconstituents | PET | ACE | MeOH | H₂O |
|-------------------|-----|-----|------|-----|
| Alkaloids         | -   | +   | +    | +   |
| Flavonoids        | -   | +   | +    | +   |
| Glycosides        | -   | +   | .    | +   |
| Steroids          | +   | +   | +    | +   |
| Saponins          | -   | -   | +    | +   |
| Tannins           | +   | +   | +    | +   |

+: Present, -: Absent, PET: Petroleum ether, ACE: Acetone, MeOH: Methanol

DISCUSSION

The results obtained by this study figured out the antimicrobial properties of J. sambac leaf extracts tested against selected dental microorganisms by using agar well diffusion method. The efficacy of crude extracts was higher against bacterial strains in comparison to fungal organism. The antimicrobial activity of PET extract observed lower compared to other extracts. According to Al-Hussaini and Mahasneh (2011), ACE extract of J. sambac leaf extract was reported most active against six bacteria i.e. S. aureus, Bacillus subtilis, B. cereus, E. coli, P. aeruginosa, Chromobacterium violaceum and one fungi i.e. C. albicans. The leaf extracts were also reported active against Xanthomonas campestris (Gracelin et al., 2012), C. albicans (18.0±0.50 mm) and Aspergillus niger (10.0±0.30 mm) (Nandhini et al., 2015). Abdoul-Latif et al. (2010) reported the antimicrobial activity of essential oil and MeOH extract of J. sambac against S. pyogenes, S. enterica, E. coli, S. dysenteriae, L. innocua and E. facealis. The MICs values tested for MeOH extract were recorded least against S. aureus and moderate against S. sanguinis and S. sobrinus. These data represent the sensitivity of tested strains.

The phytochemical screening of J. sambac extract had shown that plant contains major phytoconstituents including alkaloids, flavonoids, steroids, reducing sugars, saponins and tannins. Sabharwal et al. (2012) also reported the presence of flavonoids, steroids, glycoside, tannins and fatty acids in flowers of J. sambac. Phytochemicals are responsible for various properties i.e., antioxidant activity, hormonal action, enzymatic activity, interference with DNA replication, antimicrobial activity etc. (Doughari, 2012). In conclusion, J. sambac leaf extracts possess a broad spectrum of activity against a panel of microorganisms responsible for the dental diseases. This study can boast a new possibility for finding novel clinically effective antimicrobial compounds from J. sambac.

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REFERENCES

Abdoul-Latif, F., P. Edou, F. Eba, N. Mohamed and A. Ali et al., 2010. Antimicrobial and antioxidant activities of essential oil and methanol extract of Jasminum sambac from Djibouti. Afr. J. Plant Sci., 4: 38-43.
Aboa, O.O., S.I. Smith and F.O. Olude, 2006. Antibacterial effect of edible plant extract on Escherichia coli O157:H7. Pak. J. Nutr., 5: 325-327.
Ahmad, I., Z. Mehmood and F. Mohammad, 1998. Screening of some Indian medicinal plants for their antimicrobial properties. J. Ethnopharmacol., 62: 183-193.

Al-Hussaini, R. and A.M. Mahasneh, 2011. Antibacterial and antifungal activity of ethanol extract of different parts of medicinal plants in Jordan. Jordan J. Pharm. Sci., 4: 57-69.

Balandrin, M.F., J.A. Klocke, E.S. Wurtele and W.H. Bollinger, 1985. Natural plant chemicals: Sources of industrial and medicinal materials. Science, 228: 1154-1160.

Doughari, J.H., 2012. Phytochemicals: Extraction Methods, Basic Structures and Mode of Action as Potential Chemotherapeutic Agents. In: Phytochemicals: A Global Perspective of their Role in Nutrition and Health, Rao, V. (Ed.). Chapter 1, InTech Publisher, Rijeka, Croatia, ISBN: 978-953-51-0296-0, pp: 1-32.

Evans, W.C., 1996. Techniques in Microscopy: Quantitative Microscopy. In: Trease and Evans Pharmacognosy, Evans, W.C. and G.E. Trease (Eds.). 14th Edn., WB Saunders Co. Ltd., London, ISBN: 9780702018992, pp: 568-578.

Gracelin, D.H.S., A.J. de Britto and P.B.J.R. Kumar, 2012. Antibacterial evaluation of few South Indian medicinal flowers against plant pathogenic Xanthomonas bacteria. Int. J. Pharm. Pharmaceut. Sci., 4: 474-478.

Kononen, E., S. Asikainen, M. Saarela, J. Karjalainen and H. Jousimies-Somer, 1994. The oral gram-negative anaerobic microflora in young children: Longitudinal changes from edentulous to dentate mouth. Oral Microbiol. Immunol., 9: 136-141.

Krishnaraju, A.V., T.V.N. Rao, D. Sundararaju, M. Vanisree, H.S. Tsay and G.V. Subbaraju, 2005. Assessment of bioactivity of Indian medicinal plants using Brine shrimp (Artemia salina) lethality assay. Int. J. Applied Sci. Eng., 3: 125-134.

Marsh, P.D., 1992. Microbiological aspects of the chemical control of plaque and gingivitis. J. Dent. Res., 70: 1431-1438.

Mittal, A., S. Sardana and A. Pandey, 2011. Ethnobotanical, phytochemical and pharmacological profile of Jasminum sambac (L.) Ait. J. Pharmaceut. Biomed. Sci., 11: 1-7.

Nandhini, S.U., P.J. Bharathy and S. Rekha, 2015. Antifungal compounds from marine Streptomyces. Int. J. Pharmaceut. Sci., 7: 207-209.

Palmer, Jr. R.J., N.I. Chalmers, A.H. Rickard and P.E. Kolenbrander, 2008. Community development in bacterial biofilms of the oral cavity. Microsc. Microanal., 14: 1554-1555.

Prasad, R.N., S. Viswanathan, J.R. Devi, V. Nayak and V.C. Swetha et al., 2008. Preliminary phytochemical screening and antimicrobial activity of Samanea saman. J. Med. Plants Res., 2: 268-270.

Sabharwal, S., S. Aggarwal, M. Vats and S. Sardana, 2012. Preliminary phytochemical investigation and wound healing activity of Jasminum sambac (Linn) Ait. (Oleaceae) leaves. Int. J. Pharmacogn. Phytochem. Res., 4: 146-150.

Sclabert, A., 1991. Antimicrobial properties of tannins. Phytochemistry, 30: 3875-3883.

Schupbach, P., V. Osterwalder and B. Guggenheim, 1995. Human root caries: Microbiota in plaque covering sound, carious and arrested carious root surfaces. Caries Res., 29: 382-395.

Srivastava, S., I. Seethalakshmi and L.J. Rebecca, 2013. Antimicrobial and antioxidant properties of Cissus quadrangularis. J. Chem. Pharmaceut. Res., 5: 131-134.

Walsh, L.J., 2006. Dental plaque fermentation and its role in caries risk assessment. Int. Dentistry SA, 8: 34-40.