Back To Mother Nature: Novel Herbal Medicines In Preventing Dental Caries

Dr Rahul Deshpande⁠, Dr Vishwas Patil⁠, Dr Heeral Shah⁎⁠, Dr Anjali Ruikar⁠, Dr Sucheta Gaikwadd, Dr Gayatri Kamble, Dr Kavita Mundhed, Dr Vaishali Adsulf

a Dr. D. Y. Patil Dental College and Hospital, D. Y. Patil Vidyapeeth, Pimpri, Pune 18, India
b Deenanath Mangeshkar Hospital, Pune, India
c Department of Chemistry, Fergusson College, Pune, India
d Department of Chemistry, SP College, Pune, India
e Department of Chemistry, Anantrao Pawar College of Engineering and Research, Pune, India
f Department of Chemistry, Bharati Vidyapeeth, Pune, India

Article history:
Received: 22 January 2018
Accepted: 25 January 2018
Available online: 21 April, 2018

Corresponding Author:
Dr. Shah H.
Email: heeralshah93 (at) gmail (dot) com

Key Words:
dental caries, antimicrobial activity, medicinal plants, salivary microflora, herbal extracts

Abstract
Introduction-
Dental caries has been one of the most commonly occurring diseases in children. The oral cavity consists of complex and highly diverse microflora which varies in different individuals. Plants, the oldest source of pharmacologically active compounds, have provided man with many medically useful substances for centuries. This paper overviews a long-term research work performed by our team to analyse the antimicrobial potential of plants against cariogenic salivary microflora.

Methodology-
The derived extract of each of the plants was screened for its growth inhibition potential against microflora in salivary samples collected from children in mixed dentition age group. The microbial assay was performed using agar diffusion method in the laboratory. The zones of microbial growth inhibition produced by each plant extract were measured. The obtained results were compared with chlorhexidine, the gold standard antimicrobial agent used in dentistry.

Results-
All herbal extracts discussed in the study show variable antimicrobial properties comparable with that of gold standard-Chlorhexidine.

Conclusion-
Results obtained exhibited presence of significant antimicrobial potential in the studied extracts. These can be used in the prevention and treatment of microbial diseases of oral tissues.

Citation:
Dr. Deshpande R., Dr. Patil V., Dr. Shah H., Dr. Ruikar A., Dr. Gaikwad S., Dr. Kamble G., Dr. Mundhe K. and Dr. Adsul V., 2018. Back To Mother Nature: Novel Herbal Medicines In Preventing Dental Caries. The Journal for Dentistry. Photon 113, 295-311

© All Rights Reserved with Photon.
Photon Ignitor: ISJN54728618D882821042018
1. Introduction

Oral diseases are a major health problem globally with dental caries being one of the most prevalent disease. Dental caries is a microbial disease and is multifactorial in origin. It affects both the genders, all races, socioeconomic strata as well as all age groups (Deshpande R., et al., 2013). In 2016, the overall caries prevalence was 78.9% among primary school children of India (Hiremath A., et al., 2016).

The human saliva serves as a reservoir for useful as well as pathologic microflora which is one of the key factors responsible for the dental caries. For prophylactic processes, it seems reasonable to target the cariogenic microorganisms involved in the process of caries initiation and progression without disturbing the balance of the normal oral microflora (Deshpande R., et al., 2015).

Several antibiotics such as ampicillin, chlorhexidine, amine-fluorides, sanguinarine and phenolic antiseptics, among others, have been very effective in preventing dental caries. However, various adverse effects such as tooth and restoration staining, increase in calculus formation, diarrhoea, taste alteration and imbalance of the oral and intestinal flora have been associated with the use of these chemicals (Deshpande R., et al., 2015). These drawbacks justify the search of alternative compounds that can be employed.

Plants, the oldest source of pharmacologically active compounds, that has provided man with many medicinal substances for centuries, is now the most important source for new bioactive molecules (Ruikar A., et al., 2010). India is one of the leading countries in the wealth of traditional knowledge. The Indian trans- Himalayas and the Western Ghats, a World Heritage Site, are very rich in biodiversity. They are a treasure house for many medicinal plants of which some have importance in Ayurveda while some others have spiritual importance.

Herbal medicines are now in great demand for primary health care due to their cultural acceptability, better compatibility with human body and minimal side effects (Deshpande R., et al., 2015). Hence bioactive extracts of medicinal plants and their herbal drug formulations form a feasible alternative to the commonly used chemically synthesized drugs.

Taking into consideration the above factors, studies were designed to search for natural, preventive and therapeutic antimicrobial agents against cariogenic salivary microflora which can be used as an alternative to current gold standard- 0.2% chlorhexidine gluconate, a synthetic antimicrobial. This paper is an overview of our original research on herbal extracts of ten medicinal plants and their antimicrobial property compared against 0.2% chlorhexidine.

2. Objective of Research

To search for natural, preventive and therapeutic antimicrobial agents against cariogenic salivary microflora which can be used as an alternative to current gold standard-0.2% chlorhexidine gluconate, a synthetic antimicrobial.

3. Materials and methods

Study design-
This is a long-term study in which we have evaluated phytochemicals of 10 different plants overtime in their derived extracts. These extracts of each of the plants have been screened for antimicrobial activity against salivary microflora in whole saliva samples using agar diffusion method. Saliva samples are collected from children of age group 6-12 yrs with moderate caries activity. The obtained results were compared with 0.2% chlorhexidine mouthwash, commonly used synthetic antimicrobial agent in dentistry.

All the plants have been studied individually for a period of over 10 years now. The study design (Table No. 1) for each plant varied in the aspects of the dilution media used in preparation of the plant extracts, concentrations of the plant extracts used in antimicrobial assay and the sampling of the tested groups.

Materials
1) Plant material- The authenticated extracts of all the studied plants were prepared conventionally using various dilution media viz., acetone, ethanol, ethyl acetate, chloroform, distilled water and methanol. These derived extracts were procured from Dr. T. R. Ingle Laboratory, Department of Chemistry, S.P. College, Pune, and Department of Rasashastra and Bhaishajya Kalpana, Dr. D. Y. Patil Ayurvedic College and Hospital, Pimpri, Pune, Maharashtra, India.
2) Standard antimicrobial agent – Chlorhexidine mouthwash - 0.2% Chlorhexidine gluconate
3) Armamentarium – Diagnostic instruments-Mouth mirror, probe, explorer, tweezer. Saliva collection – Sterilized glass vial of 5ml and funnel. Saliva transport – Insulated container with ice packs. Laboratory materials and instruments as per specifications.

Selection of participants
Inclusion criteria (Deshpande R., et al., 2017):
Patients in mixed dentition period in age group of 6–12 years with moderate caries (DMFT/deft 3-6).
No history of known systemic disease.
No history of antibiotic, analgesic therapy or any other medications affecting salivary flow rate in past one month.
No use of chemical anti-plaque agents six months before the study initiation.

Exclusion criteria:
Patients not willing to participate in the study.

Saliva collection and storage (Deshpande R., et al., 2017)-
Subjects were instructed not to eat or drink at least 1 hour prior to collection of the samples. The subjects were told to rinse mouth with water and wait for 10 minutes to avoid sample dilution. The resting whole saliva of the subjects was collected by passive drooling into sterile vial, in a quiet well-lit room in the morning time from 10am to 12 noon. Saliva was allowed to accumulate in the floor of the mouth for approximately two minutes and the subject was asked to spit in funnel; saliva (3ml) was collected in vial. Samples were collected and transported to the laboratory within 2 hours in an ice box. In laboratory these salivary samples were diluted (3:1) in a sterile vial containing 1ml of normal saline and were used to inoculate on the agar plates for the further procedure of antimicrobial analysis.

Antimicrobial assay (Deshpande R., et al., 2017): (Standard method of antimicrobial assay used in biotech institutes)-
The agar well diffusion method was used to prepare the microbial inhibition assay. Sterile well of 8.0mm diameter were impregnated with the extracts of different concentrations ranging from 50µg to 4000µg per well. Adequate amount of Müller-Hinton agar was dispensed into sterile plates and was allowed to solidify under aseptic conditions. The test samples of saliva (0.1ml) were inoculated with a sterile spreader on the surface of solid Müller-Hinton agar medium in plates.

After the media was solidified, a well was made in the plates with the help of a cup- borer (8.0mm), the well was filled with different concentrations of the various extracts and plates were incubated at 37°C ± 0.1°C for 24 hours. After incubation, the plates were observed for zones of growth inhibition and the diameters of these zones were measured in millimetres by using bacterial inhibition zone reading scale. All the tests were performed under sterile conditions. Chlorhexidine was used as positive control. The lowest dose required to attain maximum inhibition of a mixed oral microflora was recorded.

4. Results

In all the studies, the results confirmed the antimicrobial potential of the plants and indicated that the extracts can be used in the prevention of infectious diseases caused by salivary microflora. The solvents used in the extraction procedure were found to have pronounced effect on the solubility of the antibacterial compounds. Significant zones of microbial growth inhibitions were observed ranging from 0-16 mm for different extracts. The concentrations used varied for each study as per the study design for each plant. In all the extracts the zone of inhibition increased with increasing concentration. For each plant, the most effective extract in various concentrations is analysed (Table 2).

The results of the antimicrobial assay of the acetone extract of Mimusops elengi showing average zones of inhibitions are reported in the Study No-1. An average zone of inhibition of 2 mm is depicted by a concentration of 450 µg and it is found to inhibit most of the saliva samples. Aqueous extract did not show any zones of inhibition against all the tested samples (Ruikar A., et al., 2010).

The results of the Study No-2 which is an antimicrobial assay of the acetone extract of Juglans regia show that a concentration of 300 µg is found to inhibit most of the saliva samples with an average zone of inhibition of 5.3 mm. Aqueous extract of Juglans regia has shown an average zone of inhibition of 1.3 mm at 300µg concentration (Deshpande R., et al., 2015).
In another study (Study No-3) five different concentrations of acetone, ethanol, ethyl acetate extracts of Morinda pubescens were evaluated, amongst which acetone extracts has shown maximum zone of inhibition of 14 mm at 800 µg (Deshpande R., et al., 2013).

The results of the antimicrobial assay of Embelia basal (Study No-4) have shown that the acetone extracts had higher growth inhibition potential (13.2 mm) as compared to ethanol (11.4 mm) and methanol (10.4 mm) extracts at 800 µg concentration (Deshpande R., et al., 2014).

The evaluation performed with methanol extracts (crude, fraction, sub-fraction) of Ehretia laevis (Study No-5) has shown feeble activity at 800 µg concentration in most saliva samples. Of these, methanol sub- fraction shows highest zone of inhibition of 8.4 mm at 800 µg concentration (Deshpande R., et al., 2014).

In Study No-6, acetone and methanol extracts of Cassia auriculata have shown maximum zone of inhibition of 16.2 mm and 13.6 mm respectively at 4000 µg concentration (Deshpande R., et al., 2011).

Crude ethanolic extract of the Artemisia pallens has shown least zone of inhibition (1.4 mm) at 200 µg concentration. It failed to exhibit any significant zone of growth inhibition at concentrations ranging from 10- 80 µg (Study No-7) (Deshpande R., et al., 2018).

The evaluation of ethanolic extracts of leaf, stem and roots of Achyranthes aspera (Study No-8) was performed using 80 µl concentration. The results depicted that all the three extracts have shown significant antimicrobial activity against salivary microflora with mean values of zones of inhibition for leaf, stem and roots extracts being 8.4 mm, 6.2 mm and 4.2 mm respectively (Deshpande R., et al., 2016).

The results of the antimicrobial assay of Polyalthia longifolia (Study No-9) have shown that the ethanol extracts had higher growth inhibition potential (1.5 mm) as compared to ethyl acetate, chloroform and acetone extracts at 200 µg concentration (Deshpande R., et al., 2018).

In Study No-10, ethyl acetate extract of Amaranthus cruentus has shown higher zone of inhibition (1.1 mm) at 50 µg concentration as compared to chloroform extract at 200 µg concentration. Acetone, ethyl alcohol and aqueous extracts of this plant have shown no significant zones of inhibition at 200 µg concentrations (Deshpande R., et al., 2018).

On evaluation, acetone extract was found to be more effective for five plants viz. Mimusops elengi, Juglans regia, Morinda pubescens, Embelia basal, Cassia auriculata. This is due to leaching of more organic compounds in this solvent. Figure-8 depicts the highest zone of inhibition and its concentration for acetone extracts of these plants.

Ethanol extract was found to be more effective for three plants viz. Artemisia pallens, Achyranthes aspera, Polyalthia longifolia. Figure-9 depicts the highest zone of inhibition and its concentration for ethanol extracts of these plants.

**Embelia basal (Vavding):**
A seasonal ayurvedic shrub. It is used as a gargle for sore throats, remedy for toothache and as ointment for treating pruritus (Deshpande R., et al., 2014).

Embelia basal has powerful anthelmintic, antioxidant and significant anti-microbial properties.

**Ehretia laevis (Ajaan):**
A seasonal tree with spiritual significance. The inner bark is used as food. Leaves are applied to ulcers and in headache.

Fruit is astringent, anthelmintic, diuretic, demulcent, expectorant and is used in diseases affecting urinary passages, diseases of lungs and spleen (Torane R., et al., 2011).

**Cassia auriculata (Tarwad) (Bhaleroa SA., Kelkar TS., 2012): An evergreen ayurvedic shrub.**
This plant is used in folk medicine to cure burns, constipation, convulsions, diarrhoea, dysuria and epilepsy.
It is also used to cure leprosy, skin diseases and syphilis. Pharmacological activities include antibacterial, antidiabetic, antifertility, anti-inflammatory antioxidant, hepatoprotective, antitumor, antifungal activities.
**Artemisia pallens (Davana):**
An evergreen herb with spiritual significance.

Used in Indian folk medicine for the treatment of diabetes mellitus (Ruikar A., et al., 2009).

Essential oil of davana is useful as antiseptic and disinfectant.

**Achyranthes aspera (Aghada):**
An annual shrub with spiritual significance. The plant is used as antiarthritic, antifertility, laxative, anti-helminthic, antiviral, anti-spasmodic, antihypertensive, anticoagulant, diuretic and anti-tumor agent.

It is also useful to treat cough, skin rash, nasal infection, chronic malaria, impotence, fever, asthma, piles and snake bites (Deshpande R., et al., 2016).

This plant is astringent, digestive, diuretic, laxative, purgative. It mostly acts as an antioxidant and anti-inflammatory agent.

**Polyalthia longifolia (Ashoka):**
An evergreen tree with spiritual significance. The plant has been commonly used for the treatment of fever, skin diseases, diabetes, hypertension and helminthiasis.

P. longifolia possesses significant biological and pharmacological activities, such as antibacterial, antifungal, antitumor, anti-ulcer and antioxidant properties (Subramanion J., et al., 2013).

**Amaranthus cruentus (Shravani math)**
(Torane R., et al., 2017):
An evergreen herb used as a leafy vegetable. It is used for young children and lactating mothers for treating constipation, anaemia, and kidney complaints.

Roots are used to treat pains in the limbs, as a tape worm expellant, wound dressing. It has antioxidant, anti-inflammatory and anti-cancer properties.

The seeds, seed oil and leaves are used to reduce blood pressure, cholesterol and weight, increase immunity, and treat anaemia, gastrointestinal tract disorders.

The use of plants for prevention and healing purposes forms the origin of modern medicine. Herbal medicines provide a source of phytochemicals and active biomolecules which can be extracted using various dilution media. A few conventional drugs derived from plant sources are Aspirin from willow bark, Digoxin from fox glove, Quinine from cinchona bark, Morphine from opium poppy. The utility of herbal medicines is also seen in dentistry. Among the many medicines used, herbs like Aloe-vera, Calendula extract are used for periodontal diseases; clove oil, garlic and propolis for tooth ache and Calendula, lavender oil, Echinacea for healing of inflamed gingiva and treating oral thrust. Oral and dental health awareness has improved tremendously over the last century but the prevalence of dental caries in children remains a significant clinical hurdle. Primary prevention of caries is important since it affects the overall health of individual. Fluoride gels, varnish applications, pit and fissure sealants, chlorhexidine mouthrinse are currently used for prevention. Along with the side effects mentioned previously the safety of chlorhexidine and fluoride in children is also questioned. Thus, these
Figure 3: Chloroform, acetone, methanol and ethanol extracts of Embelia basal.

Figure 4: Saliva Collection

Figure 5: Saliva Storage

Figure 6: Inoculation of saliva samples with a sterile spreader on the surface of Müller-Hinton agar medium in plates.

Figure 7: The sterile discs impregnated with different extracts.

drawbacks justified a need for search of alternatives.
In our studies, there is a variation in solubility of medicinally active compounds seen. The solvents used have a pronounced effect on the solubility of active compounds. Hence, acetone extract of M. pubescens, E. basal is more active than ethanol extracts while the ethanol extracts of A. pallens, P. longifolia are more active than their acetone extracts.

Also, the various concentrations of the extracts tested, aided in determining the range of antimicrobial activity of each plant. This facilitated the determination of minimal inhibitory concentration. In our study on the methanol extract of E. laevis, no zone of inhibition was seen at 100 μg whereas zone of inhibition increased upto 8.4 mm at 800 μg.

The effect of these plants and their extracts on the pathogenic organisms, evaluation of higher concentrations for toxicological investigations and further purification for drug development needs to be carried out. These properties can be used in the prevention and treatment of microbial diseases of oral tissues. Thus, these extracts can be formulated in the form of a mouthwash, gels, varnishes, lozenges or as intracanal medicaments.

### Table 1: The study design for each plant depending upon the dilution media and concentrations used in the selected plant extracts

<table>
<thead>
<tr>
<th>Sr No.</th>
<th>Plant’s name</th>
<th>Study Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study – 1</td>
<td><em>Mimusops elengi</em> (Spanish Cherry / Bakul/Maulsari)</td>
<td>Evaluation of average zones of microbial growth inhibition depicted by 150 μg, 250 μg, 300 μg and 450 μg concentrations of acetone extract of <em>Mimusops elengi</em> against microflora in saliva samples.</td>
</tr>
<tr>
<td>Study – 2</td>
<td><em>Juglans regia</em> (Walnut / Akhrot)</td>
<td>Evaluation of average zones of microbial growth inhibition depicted by 150 μg, 200 μg, 250 μg and 300 μg of acetone extract of <em>Juglans regia</em> against microflora in saliva samples.</td>
</tr>
<tr>
<td>Study – 3</td>
<td><em>Morinda pubescens</em> (Indian Mulberry / Aseti)</td>
<td>Evaluation of average zones of microbial growth inhibition depicted by 50 μg, 100 μg, 200 μg, 400 μg and 800 μg concentrations of acetone, ethanol and methanol extracts of <em>Morinda pubescens</em> against microflora in saliva samples.</td>
</tr>
<tr>
<td>Study – 4</td>
<td><em>Embelia basal</em> (Vavding / Babrang / Ambati)</td>
<td>Evaluation of average zones of microbial growth inhibition depicted by 50 μg, 100 μg, 200 μg, 400 μg and 800 μg concentrations of acetone, ethanol and methanol extracts of <em>Embelia basal</em> against microflora in saliva samples.</td>
</tr>
<tr>
<td>Study – 5</td>
<td><em>Ehretia laevis</em> (Ajaan / Chamror / Datrang)</td>
<td>Evaluation of average zones of microbial growth inhibition depicted by 50 μg, 100 μg, 200 μg, 400 μg and 800 μg concentrations of ethanol and methanol extracts of <em>Ehretia laevis</em> against microflora in saliva samples.</td>
</tr>
<tr>
<td>Study – 6</td>
<td><em>Cassia auriculate</em></td>
<td>Evaluation of average zones of microbial growth</td>
</tr>
</tbody>
</table>
| Study – 7 | *Artemisia pallens*  
(Davana / Dhavanam) | Evaluation of average zones of microbial growth inhibition depicted by 200 μg concentrations of ethanol and acetone extracts of *Artemisia pallens* against microflora in saliva samples. |
| Study – 8 | *Achyranthes aspera*  
(Aghada / Chirchira) | Evaluation of average zones of microbial growth inhibition depicted by 80 μl concentrations ethanol extracts of leaf stem and root parts of *Achyranthes aspera* against microflora in saliva samples. |
| Study – 9 | *Polyalthia longifolia*  
(Ashoka / Devdar / Putrajiva) | Evaluation of zones of microbial growth inhibition depicted by 200 μg concentrations of chloroform, ethyl acetate, acetone and ethanol extracts of *Polyalthia longifolia* against microflora in saliva samples. |
| Study – 10 | *Amaranthus cruentus*  
(Shravani Math / Chaulai / Rajgiri) | Evaluation of zones of microbial growth inhibition depicted by 200 μg concentrations of chloroform, acetone, ethyl alcohol, distilled water and 50 μg of ethyl acetate extracts of *Amaranthus cruentus* against microflora in saliva samples. |
**Table 2:** Average zone of inhibition (mm) at different concentrations depicted by various plant extracts against whole salivary samples.

<table>
<thead>
<tr>
<th>Concentration (μg)</th>
<th>Zone of inhibition (mm)</th>
<th>Concentration (μg)</th>
<th>Zone of inhibition (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>5.3</td>
<td>800</td>
<td>16.2</td>
</tr>
<tr>
<td>450</td>
<td>2</td>
<td>1,000</td>
<td>13.2</td>
</tr>
<tr>
<td>600</td>
<td></td>
<td>1,500</td>
<td></td>
</tr>
<tr>
<td>900</td>
<td></td>
<td>2,000</td>
<td></td>
</tr>
<tr>
<td>1,200</td>
<td></td>
<td>2,500</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 8:** Highest zone of inhibition and its concentration for acetone extracts of plants.
Figure 9: Highest zone of inhibition and its concentration for ethanol extracts of plants.

Figure 10: Mimusops elengi tree with fruits and flowers.
Figure 11: Juglans regia tree.

Figure 12: Morinda pubescens tree with flowers.
Figure 13: Embelia basal plant.

Figure 14: Ehretia laevis tree.
Figure 15: Cassia auriculata plant.

Figure 16: Plant Artemisia pallens.
**Figure 17:** Achyranthes aspera plant.

**Figure 18:** Polyalthia longifolia- an evergreen tree.
5. Discussion

In the studies conducted by our team we have successfully evaluated the antimicrobial activity of ten different plants and their extracts by analysing the inhibition of growth in the saliva samples using agar diffusion method.

*Mimusops elengi (Bakul) (Ruikar A., et al., 2010):*
- An evergreen ayurvedic tree.
- The bark, flowers, fruits and seeds have astringent, antiuretic, anthelmintic properties.
- It is mainly used in dental ailments like bleeding gums, pyorrhea and mobile teeth.
- Extract of flowers used against heart diseases, menorrhagia and act as antiuretic in polyuria.
- Decoction of bark is used to wash the wounds.

*Juglans regia (Akhrot):*
A seasonal ayurvedic tree.
Juglans regia Linn is a medicinal plant that has been widely used in traditional medicine for a wide array of ailments that include helminthiasis, diarrhoea, sinusitis, stomach ache, arthritis, asthma eczema, scrofula, skin disorders, and various endocrine diseases such as diabetes mellitus, anorexia, thyroid dysfunctions, cancer and infectious diseases (Taha N, Al-wadaan M., 2011).

**Morinda pubescens (Indian mulberry):**
A small evergreen ayurvedic tree.
It has been reported to have a broad range of health benefits for subjects with cancer, infections, arthritis, diabetes, asthma, hypertonser and pain (Krishnaiah D., et al., 2012).
These properties include antioxidative, antibacterial, anti-viral, and anticancer activities, as well as analgesic effects

**Conclusion**

In today’s evidence-based world, we have successfully tried providing evidence to the observational science of these folk medicines. Combining the knowledge of traditional systems like Ayurveda with innovative techniques of modern science provides new functional leads to reduce time, money and toxicity – the three main hurdles in drug development!
Research Highlights

Herbal drug formulations form a feasible alternative to the commonly used chemically synthesized drugs due to their cultural acceptability, better compatibility with human body and minimal side effects.

The results confirmed the antimicrobial potential of the plants and indicated that the extracts can be used in the prevention of infectious diseases caused by salivary microflora.

These extracts can be formulated in the form of a mouthwash, gels, varnishes, lozenges or as intracanal medicaments for use in dentistry.

Limitations

We have conducted the study using whole saliva which had diverse micro-organisms present in it.

Identification and isolation of micro-organisms should be done and efficacy of each extract should be tested against each individual microbe.

Recommendations

The effect of these plants and their extracts on individual pathogenic organisms, evaluation of higher concentrations for toxicological investigations and further purification for drug development needs to be carried out.

Authors’ Contribution

Dr Rahul Deshpande (Professor), Dr Vishwas Patil (Reader), Dr Heeral Shah (Postgraduate student): Concept, clinical inputs and compilation of research.

Other authors: formulations of various extracts.

Acknowledgement

Dr. Patil’s Dental Care Centre, Pune: 18 Oral Health Clinic, Pune: 04

References


Utility and importance of walnut, Juglans regia Linn: A review. African Journal of Microbiology