Plants are a valuable source of natural products for maintaining health, since time immemorial. The past few decades has witnessed an overwhelming increase in the development of modern drugs from plant products. India is bestowed with medicinal plants which are widely used for folk therapeutics and in Siddha, Unani and Ayurveda systems of medicine. The present study is an attempt to evaluate the antibacterial activities of *Alpinia galanga*, *Ayapana triplinervis*, *Aegle marmelos* and *Euphorbia hirta* against a panel of bacteria. *K. pneumonia*, *E. coli* and *Salmonella* sp. are sensitive to all the extracts tested. *P. aeruginosa* was resistant to *A. marmelos* and *E. hirta* extracts while *Citrobacter* sp. was resistant towards *E. hirta* methanolic extract only. *S. aureus* also showed resistance against *A. triplinervis*. The study demoed that the methanolic and petroleum ether extracts of the selected plants comprise antibacterial principles as usurped by indigenous herbal healers.

### ABSTRACT

**INTRODUCTION**

Multi-drug resistance among microbial strains and the appearance of strains with reduced susceptibility to current antibiotics are steadily increasing which is attributed to indiscriminate use of broad-spectrum antibiotics along with increasing population of immunocompromised individuals (Senka et al., 2008; Levy and Marshall, 2004). Currently, the chemical and pharmacological constituents of medicinal plants are widely utilized in different traditional systems of treatment globally and are growingly inquired for human well being (Patwardhan, 2005). The Indian system of medicine has medicinal plants as its cradle which is time tested in varied geographic and climatic zones across the country. The quest for more and more drugs from botanical origin is incessantly increasing which demands sieving of medicinal plants with sufficient biological activities. The present study is an attempt to evaluate the antibacterial activities of selected medicinal plants which are traditionally used by traditional healers like *Alpinia galanga*, *Ayapana triplinervis*, *Aegle marmelos* and *Euphorbia hirta* against a panel of bacteria such as *Escherichia coli*, *Citrobacter* sp., *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Salmonella* sp. and *Staphylococcus aureus*.

**MATERIALS AND METHODS**

**Plants selected**

*Alpinia galanga* (Zingiberaceae)

The plant is consistently used by South Indian physicians of traditional Ayurveda and Siddha medicine system to treat various ailments. The plant has uses like cardiactonic, diuretic, hypotonic, gastric lesions, antipatelet, anti-tumor, anti-fungal, carminative, irritant action, whooping cough in children, bronchitis, anti-asthma, dyspepsia, fever and diabetes mellitus (Verma et al., 2011).

*Ayapana triplinervis* (Asteraceae)

The plant is widely used in folk medicine due its analgesic, anticoagulant, antianorexic, antiparasitic, anesthetic, sedative and antimicrobial properties. Leaves are used through infusions, decoctions, baths, and tea. It is largely used in Brazilian folk medicine as digestive, febrifuge, stimulant, tonic and anti-inflammatory (Bose et al., 2007).

*Aegle marmelos* (Rutaceae)

The plant is widely used in indigenous systems in Indian medicine due to its multifarious activities. The plant is considered scared in Hindu tradition and offered in prayers to Lord Shiva and Parvathi and hence the name Shivduma (tree of Shiva). Different parts of the plant are used for various therapeutic uses like asthma, anaemia, fractures, healing of wounds, swollen joints, high blood pressure, jaundice and diarrhea. It is used as a herbal medicine for the management of diabetes mellitus in Ayurvedic, Unani and Siddha systems of medicine (Sharma et al., 2011).

*Euphorbia hirta* (Euphorbiaceae)

The plant is native to India but is a pan tropical weed, found especially on roadsides and wasteland. The plant is used for female disorders, respiratory ailments, especially cough, coryza, bronchitis and asthma. The plant is commonly used to treat worm infestations in children and for dysentery, jaundice, pimples, digestive problems and ethnoveterinary usages (Asha et al., 2014).

**Extract preparation**

Leaves of the plants (Ayapana triplinervis, Aegle marmelos and *Euphorbia hirta*) and rhizome (*Alpinia galanga*) were collected from different regions in Kottyam District and taxonomically identified by using standard taxonomic keys and expert consultations. The collected plants were dried under shade, crushed and subject to soxhlet extraction with petroleum ether and methanol. The extract was filtered and concentrated.

**Antibacterial susceptibility testing**

Pure cultures of *Escherichia coli*, *Citrobacter* sp., *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Salmonella* sp. and *Staphylococcus aureus* were used for the study. The strains were maintained on nutrient agar slants at 4°C. A loopful of each bacterial strain was added to a 50 ml sterile nutrient broth in a 100 ml conical flask. The flasks were then incubated for 24 h to activate the test strain.

**Agar diffusion method**

The antibacterial activity of the selected plant extracts was obtained with two different solvents - petroleum ether and methanol which was assessed by the agar diffusion method (Balouiri et al., 2016). The agar plate surface is inoculated by spreading of the microbial inoculum uniformly over the entire agar surface. Then, a hole with a diameter of 6 to 8 mm is punched aseptically with a sterile cork borer and a volume (50 µL) of the extract was introduced into the well. Then, agar plates are incubated overnight. The antimicrobial agent diffuses in the agar surface and inhibits the growth of the microbial strain tested. The antibacterial activity was determined by measuring the zone of inhibition and expressed as millimeter (mm). Five sets of plates are used for the antimicrobial studies. Control plates were also maintained for the study.
RESULTS

The antibacterial activities of Alpinia galanga, Ayapana triplinervis, Aegle marmelos and Euphorbia hirta against a bacterial pathogens such as Escherichia coli, Citrobacter sp., Pseudomonas aeruginosa, Klebsiella pneumoniae, Salmonella sp. and Staphylococcus aureus was conducted. The obtained results are given Table 1. In an overall analysis K. pneumoniae, E. coli and Salmonella sp. are sensitive to all the tested extracts. P. aeruginosa was resistant to A. marmelos and E. hirta extracts while Citrobacter sp. was resistant towards E. hirta methanolic extract only. S. aureus also showed resistance against A. triplinervis. K. pneumoniae and E. coli are more sensitive towards the tested extracts. The highest zone of inhibition was exhibited by A. triplinervis methanol extract against Citrobacter sp. and E. hirta methanol extract against S. aureus.

**Table 1: Sensitivity pattern of tested extracts**

<table>
<thead>
<tr>
<th>Bacteria tested</th>
<th>Plants tested</th>
<th>Zone of inhibition (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PE</td>
<td>M</td>
</tr>
<tr>
<td>Citrobacter sp.</td>
<td>24±1 03</td>
<td>21</td>
</tr>
<tr>
<td>P. aeruginosa</td>
<td>19±3 44</td>
<td>17</td>
</tr>
<tr>
<td>E. coli</td>
<td>20±1 19±1 64</td>
<td>16</td>
</tr>
<tr>
<td>S. aureus</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>K. pneumoniae</td>
<td>24±1 67</td>
<td>27</td>
</tr>
<tr>
<td>Salmonella sp.</td>
<td>16±2 27±2</td>
<td>90</td>
</tr>
</tbody>
</table>

The antimicrobial activities of the methanolic extracts of *Euphorbia hirta* leaves, flowers, stems and roots were evaluated with promising results (Rajeh et al., 2010). *E. hirta* is a very popular herb among the practitioners of traditional medicine around the world. Moreover, it is used as an antidote and pain relief of scorpion stings and snakebites. The use of the latex to facilitate removal of thorns from the skin is also common.

CONCLUSION

Phytochemicals are cheap and serving not only as functional food but also as nutraceuticals. It should be noted that herbal medicine is still the mainstay of more than 80% of the whole population, especially in developing countries. The results of the study ponder the presence of effective plant based antimicrobials with motleying inhibition patterns. Further research in this line is the need of the hour, as drug resistance and disease causalities are on the rise.

REFERENCES

- Rajeh, M.A.B., Zuraini, Z., Sasidharan, S., Latha, L.Y. and Amutha, S. 2010. Antibacterial activity of...
