Ethnobotanical and pharmacological profile with propagation strategies of *Mukia maderaspatana* (L.) M. Roem.–A concise overview

A J A Petrus

Department of Chemistry, Kanchi Mamunivar Centre for Post-Graduate Studies (Autonomous), Puducherry-605 008, India

Received 27 June 2011; Accepted 26 November 2012

*Mukia maderaspatana* (L.) M. Roem. (Family: Cucurbitaceae) [syn. *Melothria maderaspatana* (L.) Cogn.] grows common in village hedges and other open habitats and in the disturbed sites of the semi-evergreen and deciduous forests. It is distributed throughout the tropics and subtropics of the Old World, where different parts of the plant are being utilized for the health-care needs of human beings and livestock. The leaves and tender shoots are also frequently consumed as a part of the South Indian cuisine. Preclinical animal experiments have substantiated a number of traditional and folkloric medicinal claims, including hypotensive, hypolipidemic, hepatoprotective, hypoglycaemic, immunomodulatory, antimicrobial, antiplatelet-aggregation, antiulcer, anxiolytic and local anaesthetic characteristics of the plant extracts. Encouraging results have emerged from clinical investigations also as a chemoprotective plant in subjects suffering from hypertension, diabetes, dyslipidemia and rheumatoid arthritis. The present review aims to offer a concise pioneering account of (i) the ethnomedical uses of the leaves, tender shoots, stem, fruits and roots of the drug-plant among various traditional communities inhabiting different parts of the world, (ii) the motivating outcome of the preclinical and clinical investigations of the plant extracts and (iii) progress attained in the techniques of propagation of this potentially useful indigenous functional food plant which is currently tending to transform as an endangered taxon.

Keywords: *Mukia maderaspatana*, Cucurbitaceae, Functional leafy vegetable, Traditional uses, Pharmacological profile, Micro-propagation.

IPC code; Int. cl. (2011.01)—A61K 36/00

**Introduction**

India has one of the world’s most sophisticated indigenous medical cultures with an unbroken tradition, inherited by generations over the past four millennia. It is one of the leading countries in Asia in terms of the wealth of traditional knowledge systems relating to the use of plant species for medicinal purpose. Though this medical heritage is several centuries old, people in the rural and remote areas still depend upon it for their health care needs. Tribal use of plants is also characterised by diversity in choice. While the majority of human population rely on about 100-150 plant species for most of their requirements, the traditional tribal communities living in southern India use 1,000-1,500 species of plants and a variety of these are edible greens. *Mukia maderaspatana* (L.) M. Roem. (Family: Cucurbitaceae) [syn.: *Cucumis maderaspatanus* L.; *C. maderaspatana* (L.); *C. pubescens* Willd.; *Bryonia cordifolia* L.; *B. althaeoides* Ser.; *B. scabrella* L.f.; *B. rotterli* Spreng.; *Coccinia cordifolia* (L.) Cogn.; *Melothria maderaspatana* (L.) Cogn.; *M. althaeoides* (Ser.) Nakai; *M. celebica* Cogn. var. *villosior* Cogn.; *M. leiosperma* auct. non (Wight & Arn.); *Mukia scabrella* (L. f.) Arn. *M. maderaspatana* (L.) M. Roem. var. *scabrella* (L.) Kurz; *M. maderaspatana* var. *gracilis* Kurz; *M. rotterli* (Spreng.) M. Roem.; *M. althaeoides* (Ser.) M. Roemer; locally, *musumusukkai* (Tamil); *trikosaki* (Sanskrit); *melon-gubat* (Filipino)) is a functional food plant (Plate 1), with the distribution throughout the tropics and subtropics of the Old World¹. The local names of the plant among various cultures in different parts of the world are summarised in an earlier publication¹. The present review attempts to compile the traditional uses of the plant, including its culinary value, prescriptions in the coded indigenous medical systems as well as in the tribal medical practices, together with the published pharmacological profile. Efforts have also been taken to highlight the extent of the heights reached in addressing the issues of its propagation/regeneration.

**Traditional uses**

As indigenous functional leafy vegetable

Tribal use of plants, their food habits and dietary patterns are characterised by diversity in choice. A
variety of plants find use as edible greens. Presently, accumulating evidences from preclinical animal experiments and clinical evaluations point to the close association between diet and the widely prevalent chronic illnesses, including cardiovascular diseases (CVD), cancer, allergy, obesity and diabetes\textsuperscript{2}. Consequently, the current focus of nutrition research is heading towards the concept of ‘preventive medicine’, resulting in the study of health-related edible plants gaining its momentum\textsuperscript{3}. Wild sources of food, in general, appear more common and widespread in food insecure areas, where a diverse kind of species is consumed\textsuperscript{4}. They continue to be important for the less privileged and gain more significance during the times of calamities and when the local or displaced populations do not have the access to traditional food. The Paniya, Kuruma and Kattunaikka communities\textsuperscript{4} and Palliyars\textsuperscript{5} of the Western Ghats and reportedly certain tribes of the West Himalaya\textsuperscript{6}, gather M. maderaspatana as wild edible greens. However, even under normal conditions, wild plants play a significant role in complementing staple foods to provide a balanced diet by supplying a number of antioxidant phytometabolites, essential and trace minerals, vitamins, and fibres\textsuperscript{7-10}. Their interest as a source of nutraceuticals has also been highlighted widely in literature\textsuperscript{11}. In this aspect, the leaves, stems and fruits, both ripe and unripe, as well as the roots of this plant are reported to be used as a functional vegetable among various communities\textsuperscript{12-15}. The leaves and tender shoots are frequently used by South Indians to prepare crispy savoury pancake, called dosa\textsuperscript{12}. Delicious leaf paste, locally known as chutney or thuvayal is used to add taste to cooked rice, idli, dosa, etc and a number of such musumusukkai recipes are also available in the internet.

In the Indian system of medicine

India has a population with high degree of medical pluralism and Trikosaki is important for its numerous medicinal values. One can encounter the herb common in village hedges and other open habitats and in the disturbed sites of the semi-evergreen and deciduous forests. Several medicines are prepared from its different parts. According to Ayurveda, the plant is reported to possess expectorant, refrigerant, carminative, aperient, vulnerary, sudorific, anodyne and tonic values, and offer relief from asthma, cough, burning sensation, dyspepsia, flatulence, colic, constipation, ulcers, neuralgia, nostalgia, odontalgia and vertigo\textsuperscript{16-18}. The fruits are reportedly used in the treatment of dysuria, piles, polyuria and tuberculosis\textsuperscript{19,20}. The drug is an ingredient of the Ayurvedic preparations, like Pipalyasava, Rasayanarishta, Srikandasava and Manasamitra vatakam, according to the descriptions in Sarngadhra Samhita, Bhaishajya Ratnavali, Kadhanikragam, Yogaratnagaram and Sahasrayaham. In Siddha, the root and leaf are used to treat fever, dyspnoea, abdominal disorders, hepatic disorders, cough and vomiting and the leaf decoction to treat hypertension (HT) and nasobronchial diseases\textsuperscript{21}. Herbal vendors of Tamil Nadu sell a preparation, labelled kabha marundhu, to treat nasobronchial diseases\textsuperscript{22}. It is a laeohium (sweetened herbal paste), prepared from the leaves of M. maderaspatana, Ocimum sanctum L., Pergularia daemia (Forsk.) Chiov., Solanum trilobatum L. and Tylophora zeylanica Decne, in combination with Allium sativum L. (bulb) and Cissus repens Lam. (stem) and administered orally (25 g/d, 5 d). The drug is also marketed in India, either alone or in combination with other plant-drugs, under the trade names: Asthacure, Asthmex, Bronkease, Respease and Musumusukkai chooranam, for treating bronchial asthma, allergic bronchitis, chronic bronchitis, bronchiectasis, productive cough and cold, upper and lower respiratory tract infections and difficulty in breathing. In Naturopathy, the plant drug is claimed to strengthen lungs and other organs associated with breathing and controls endless cough, cold, wheezing, allergy, dry cough, sneezing, lethargy, tuberculosis and asthma. M. maderaspatana is also a folkloric medicinal plant\textsuperscript{23-26} and a veterinary drug among various communities of India\textsuperscript{27}.

In ethnobotany/ethnomedicine

Living in harmony with nature has been both a way of life and a means to livelihood among the indigenous
tribal communities. This has led them to evolve a unique system of knowledge about the utilization and conservation of plant genetic resources by way of trial and error. This traditional knowledge has been passed on from generation to generation by word of mouth and is still retained by the tribal communities. Folkloric traditional medicine claims that the leaves and tender shoots are useful as aperients, diuretic, stomachic, antipyretic, antiflatulent, antiasthmatic, antitussive, antihistaminic, antibronchitic and as an expectorant, in addition to its prescription against vertigo and biliousness. Traditional medical practitioners of certain regions have also been found to use the leaf-tea for the alleviation of jaundice. Mupatena tea, the extract of the leaves and bark is reported to be a good decongestant and a very good remedy for cough, cold and flu. Decocted seeds are reported to be sudorific and are used to relieve flatulence. The seeds are reported to contain cumin and are claimed to relieve toothache, when masticated. The Mundas of the Chota Nagpur Plateau region have been reported to apply the crushed seeds on aching bodies, especially on strained backs.

An increasing interest in wild edible plants has led to a number of ethnobotanical surveys. This topic has become currently relevant following the concern of the FAO about the decline of dietary diversity and the concomitant rise in chronic diseases that are affecting developing countries and, particularly, the poor. The cross-cutting initiative on biodiversity for food and nutrition, therefore, promotes the use of local biodiversity, including traditional foods of indigenous and local ecosystems with their many sources of nutritionally-rich species and varieties as readily-accessible, locally-empowering and sustainable sources of quality nutrition. Studies on human-nature relationships and informations gathered from various sections of the traditional Indian population on ethnobotany of wild edible and medicinal plants, conservation of plant genetic resources and sacred grove method of genetic conservation have provided a wealth of information on the ethnomedical significance of the wild edible plant, M. maderaspatana (Table 1). Musumussukkai is reported to be a commonly used ethnomedicinal plant of the Kani traditional healers, the oldest South Indian ethnic community, inhabiting the Tirunelveli hills of the Western Ghats. It is generally sold by vegetable vendors throughout South India. The Kanikkars trace their knowledge of medicinal plants back to the Hindu saint and holy man, Agasthiyar Muni, who is credited as the founder of Siddha system of medicine, 2000 years ago. The authors have listed the plant to possess the highest fidelity level of 100%, in their article, indicating the 100% choice of the interviewed informants. Perusal of published literature has also brought to light the ethnobotanical uses of the plant among the native communities inhabiting other parts of the globe (Table 2).

In livestock health and diseases

M. maderaspatana is also widely used in the health-care of livestock. In Andhra Pradesh (India), the leaves, pounded with garlic, pepper and cumin, are used for treating hygroma in cattle. An indigenously prepared herbal bolus, containing the plant, is claimed to be useful in increasing body immunity and in controlling digestive disorders of cattle. The Bashi tribe (Bantu origin) living in the Bushi area of the Kivu Province (Democratic Republic of Congo), use the plant, processed in combination with other medicinal plants, to treat a number of livestock diseases. These include adenitis, piroplasmosis, thelieriasis, plague, anthrax, rabies, madness, anaplasmosis and gastroenteritis. The crude plant extract of the leaf is reported to show moderate toxicity against the adult cattle tick Haemaphysalis bispinosa Neumann, 1897 and the sheep fluke Paramphistomum cervi Zeder, 1790 at a concentration of 2500 ppm and the early fourth instar larvae of Anopheles subpictus Grassi, Japanese encephalitis vector, Culex tritaeniorhynchus Giles at 1000 ppm. The petroleum ether (PEF), hexane (HF), ethyl acetate (EAF), acetone (AF) and methanol (MF) fractions have been found to exhibit moderate larval toxicity against the West Nile virus, and filariasis causing vector, C. quinquefasciatus Say, 1823 after 24 h exposure. Bagavan et al., however, have reported only the MF to be active against P. cervi.

Pharmacological profile–Preclinical animal experiments

Antihypertensive activity

Long-term administration of deoxycorticosterone acetate (DOCA)-salts to rats induces sodium retention and high salt intake leads to volume-dependent HT. HT is a well-defined risk factor for CVD and the single most important cause of strokes and coronary heart disease. The involvement of reactive species (RS), especially the oxygen and nitrogen species, in the pathogenesis of vascular diseases, including
<table>
<thead>
<tr>
<th>Community/Locality</th>
<th>Ethnomedical uses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tamil Nadu</strong></td>
<td></td>
</tr>
<tr>
<td>1. Kani Tribe of Agasthiyar Kani kudiruppu, Chinna Mayilar, Periya Mayilar, Inchikuzhi and Servalar of Tirunelveli hills</td>
<td>A paste of the leaves is consumed orally to derive general good health and disease resistance.</td>
</tr>
<tr>
<td>2. Kanikkars of Karayar, Adukku parai, Chinna mayilar, Periya mayilar, Valuar and Inchikuzhi, Tirunelveli district</td>
<td>Fresh leaf-juice is consumed orally to get relief from cold and cough.</td>
</tr>
<tr>
<td>3. Kanikkars of Kalakad-Mundandurai Tiger Reserve region of Agasthiyamalai biosphere, Western Ghats, Tirunelveli district</td>
<td>Leaf paste is externally applied to treat wounds, scabies and the ringworm infection.</td>
</tr>
<tr>
<td>4. Kani Tribe of Agasthiyamalai Biosphere Reserve (Servalar, Agasthiar Kanikudiyiruppu, Mayilar, Periya mayilar and Inchikuzhi’s tribal settlements) of Tirunelveli region</td>
<td>Leaf juice is consumed to cure giddiness.</td>
</tr>
<tr>
<td>5. Palliyar tribal community settled in the reserve forest area of the Grizzled Giant Squirrel Wildlife Sanctuary of the Western Ghats; Srivilliputhur in Tamil Nadu</td>
<td>Leaves and young fruits are administered to treat ulcer and urinary complaints.</td>
</tr>
<tr>
<td>6. Rural communities of the sacred groves and adjoining environments of Pudukkottai district</td>
<td>To treat symptoms of burning sensation, dyspepsia, flatulence, colic, ulcers, cough, asthma, neuralgia, notalgia, odontalgia and vertigo.</td>
</tr>
<tr>
<td>7. Local communities with indigenous knowledge living around various sacred groves of Pudukkottai district</td>
<td>Leaf-extract is consumed internally to cure piles; applied to the hair to blacken gray hair.</td>
</tr>
<tr>
<td>8. Local medicine men and aged farmers of Mallagainathan village, Pudukkottai district</td>
<td>Leaf-juice with gingelly oil to relieve body irritation.</td>
</tr>
<tr>
<td>9. Thottianiackans/Vaettainayakkans/Kambalathunayakkars inhabiting Ondibommanayakkanpatty, Desimayakkanpatty, Kandamanayakkanpatty, Valiapatty, Palattanayakkarr hamlets of Semmalai hills</td>
<td>Equal volumes of the leaves of <em>M. maderaspatana</em> and <em>Cassia italica</em> and seeds of <em>Tephrosia purpurea</em> are ground and made into paste and applied as antidote for insect and scorpion bite.</td>
</tr>
<tr>
<td>10. Various ethnic groups, villagers, traditional healers (vaidhyas) of Madurai, Dindigul, Sivagangai, Thiruchirappalli, Theni and Viruthunagar districts</td>
<td>Leaves and roots are used as traditional oral care medicine to relieve toothache.</td>
</tr>
<tr>
<td>11. Paliyar Tribes of Shenbagathope in Virudhunagar district</td>
<td>Decoction of root is used for the relief of tooth-ache.</td>
</tr>
<tr>
<td>12. Kurangani, Arasaradi/Notchioodai, Attupparai/Kathrikaparai, Karattupatti, Manjalaru, Munthal, Thazhaiuthu and Velapparkovil villages of Theni district</td>
<td>Fruit is used against cough. Paste of the fresh leaves is administered orally to cure throat infection.</td>
</tr>
<tr>
<td>13. Paliyans and Pulayans of Lower Palani Hills</td>
<td>Green leaf salad to relieve stomach upset.</td>
</tr>
<tr>
<td>14. Valaiyans of Oduvanpathi, Valaiyankulathupatti, Ammankolvilpathi, Silambkkonpathi, Melavanayeirippu, S. Puthur, which are situated around the Piranmalai Hills</td>
<td>The root is made into a paste and taken internally to control dysentery; the root paste along with <em>Allium sativum</em> and <em>Zingiber officinalis</em> is administered internally to treat piles.</td>
</tr>
<tr>
<td>15. Valaiyans of Madurai district</td>
<td>Leaf juice prepared using rice fermented water is taken orally to reduce bile accumulation (pittham). Leaf powder is consumed with rice water to relieve chest pain.</td>
</tr>
<tr>
<td>16. Valaiyans of Pallapatty, Vallaicheripatti, Valaiyanendal, Ma hill and Thulukka rock hamlets along the Vellimali hills Madurai district</td>
<td>Leaf-juice with gingelly oil is applied topically on the head before taking bath to cure asthma.</td>
</tr>
<tr>
<td>17. Irula Tribes of Hasanur Hills, Erode district</td>
<td>Leaf-extract is consumed internally to cure piles; applied to the hair to blacken gray hair.</td>
</tr>
<tr>
<td>18. Indigenous population of Kothattai, Chinna Komati, Chinna thana kuppam, Venagdam pettai and Kuzhandhai kuppam sacred groves in Cuddalore district</td>
<td>(Contd.)</td>
</tr>
<tr>
<td>Community/Locality</td>
<td>Ethnomedical uses</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>19. Villagers of Cuddalore, Chidambaram and Kattumannarkovil taluks of Cuddalore district&lt;sup&gt;49&lt;/sup&gt;</td>
<td>Leaf and seed extract to treat toothache, piles and tuberculosis.</td>
</tr>
<tr>
<td>20. Aborigines of Cuddalore, Villupuram, Kanchipuram and Thiruvalluvar districts&lt;sup&gt;50&lt;/sup&gt;</td>
<td>The plant is used to treat cold and cough.</td>
</tr>
<tr>
<td>21. Malasar of Kozhikamuthi, Anamalai hills, Coimbatore district&lt;sup&gt;13&lt;/sup&gt;</td>
<td>The plant is used to treat antifertility.</td>
</tr>
<tr>
<td>22. Traditional healers of Kancheepuram district&lt;sup&gt;51&lt;/sup&gt;</td>
<td>Leaf powder is mixed with boiled rice and taken orally to treat cold and cough.</td>
</tr>
<tr>
<td>23. Malayali tribe of Vattal Hills, Dharmapuri District&lt;sup&gt;52&lt;/sup&gt;</td>
<td>Fresh, ground leaf-paste is applied externally to treat scabies and ringworm infection.</td>
</tr>
<tr>
<td>24. Villagers of Dharapuram Taluk&lt;sup&gt;53&lt;/sup&gt;</td>
<td>Leaf extract is used against pitha disease. Leaf juice, mixed with food is given for body stimulation. Fruit decoction is given to children to improve memory. Root paste is used in toothpaste.</td>
</tr>
<tr>
<td>25. Traditional medicine users of Villupuram district&lt;sup&gt;54&lt;/sup&gt;</td>
<td>Leaf-juice to treat asthma and allergy. Root extract combined with Cuminum cyminum is used treat spermatorrhea.</td>
</tr>
<tr>
<td>26. Local inhabitants of Vellore district&lt;sup&gt;55&lt;/sup&gt;</td>
<td>Leaf-extract is consumed internally to cure piles; applied to the hair to blacken gray hair.</td>
</tr>
<tr>
<td>27. Malasars of Dravidian Tamils in the Venliangiri holy hills of the Western Ghats&lt;sup&gt;56&lt;/sup&gt;</td>
<td>Leaves are consumed on a regular basis to aid their general health and to provide relief from chronic bronchitis.</td>
</tr>
<tr>
<td>28. Traditional communities and Vaidhyas belonging to the areas adjoining the dry evergreen scrub jungles of Puducherry, Villupuram and Cuddalore&lt;sup&gt;12,57&lt;/sup&gt;</td>
<td>Leaves are consumed to cure cold and cough.</td>
</tr>
</tbody>
</table>

**Kerala**

<table>
<thead>
<tr>
<th>Community/Locality</th>
<th>Ethnomedical uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>29. Paniya, Kuruma and Kattunaikka tribes of Wayanad District&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Leaves and young fruit are used to treat ulcer and urinary complaints.</td>
</tr>
<tr>
<td>30. Paniya tribe of Wayanadu district&lt;sup&gt;58&lt;/sup&gt;</td>
<td>Fruit is used in the treatment of Paronychia.</td>
</tr>
<tr>
<td>31. Mullu kuruma tribe of Wayanad district&lt;sup&gt;49&lt;/sup&gt;</td>
<td>Fruit pulp is used in the treatment of Paronychia.</td>
</tr>
</tbody>
</table>

**Andhra Pradesh**

<table>
<thead>
<tr>
<th>Community/Locality</th>
<th>Ethnomedical uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>32. Tribal medicine people, rural vaidhyas of Adilabad district&lt;sup&gt;60&lt;/sup&gt;</td>
<td>Leaf-paste applied to head before the bath twice or thrice a week to control dandruff.</td>
</tr>
<tr>
<td>33. Chenchus, Erukulas, Lambadas, Koyas, Kondareddies, Nukadoras and Yanadis ethnic people of the Eastern Ghats region (Chittoor, Cuddapah, East Godavari, Guntur, Khammam, Krishna, Kurnool, Srikakulam, Visakhapatnam, Vijayanagaram and the West Godavari districts&lt;sup&gt;61&lt;/sup&gt;).</td>
<td>An extract made from a fistful of the whole plant of this species, crushed with 10-12 g. of ginger, pepper and a pinch of musk, is consumed twice a day for three days is claimed to be a good remedy for cold and cough.</td>
</tr>
<tr>
<td>34. Acharya Nagarjuna University, Guntur district&lt;sup&gt;62&lt;/sup&gt;</td>
<td>Plant is prescribed against chronic diseases and as a relief from toothache.</td>
</tr>
</tbody>
</table>

**Madhya Pradesh**

<table>
<thead>
<tr>
<th>Community/Locality</th>
<th>Ethnomedical uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>35. Gond, Korku, Pardhan, Bharda-Bhumia, Baima, Bhil, Kamwar, Nihal, Pardhi and Mabasi tribal communities of Hoshangabad district&lt;sup&gt;63&lt;/sup&gt;</td>
<td>Leaf paste mixed with jagri is administered for the removal of the effect of poison of scorpion bite.</td>
</tr>
<tr>
<td>36. The Oraon, Bhrior, Agaria, Korwa, Nagesia, Baiga and Gondiya tribal population of Dharamjarh, Ghatghora, Parthalgaon hamlets of Raigarh district, Chhatisgarh&lt;sup&gt;64&lt;/sup&gt;</td>
<td>Leaf powder, in combination with Cassia fistula stem-bark powder, Piper nigrum and Allium cepa, is administered internally to control dysentery.</td>
</tr>
</tbody>
</table>

(Contd)
Table 1—Ethnomedical uses of *M. maderaspatana* among various cultures of India—(Contd)

<table>
<thead>
<tr>
<th>Community/Locality</th>
<th>Ethnomedical uses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maharashtra</strong></td>
<td></td>
</tr>
<tr>
<td>37. Bhills, Gavits, Kokanis, Mavachis, Valvis, Pawras, Kokna and Vasaves tribes inhabiting Karanpada, Moranba, Ratanbara, Kolvimal, Kuwa, Ambabari, Aaml, Dab, Aamoni, Rapapur, Lakkadkot, Kotlar, Bandhara, Dhanpur, Muktarzira, Mandvi Kh, Nigadi, Telkhedi, Godamba, Jugani, Welkhedi, Khadki and Kalapani of Nandurbar district (West Khandesh)</td>
<td>Root is chewed for about 15 min to relieve toothache.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Rajasthan</strong></td>
<td></td>
</tr>
<tr>
<td>38. Medicine men, local men and women working in the field, priests, village headman and birth attendants of Sitamata Wild life sanctuary, Chittorgarh district</td>
<td>Seeds and roots are used against diabetes, diarrhoea and toothache.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Gujarat</strong></td>
<td></td>
</tr>
<tr>
<td>39. Local tribals belonging to Saraswati river region of Patan district</td>
<td>Decoction of the whole plant is given in colic. Leaf-paste is applied on ulcers. Fruits are eaten to control worms. Roots are chewed to alleviate toothache.</td>
</tr>
<tr>
<td>40. Maher tribe in Porbandar district; Palej and Delva villagers of Bharuch district of Gujarat</td>
<td>½ cup leaf-juice and 10g seed powder mixed and given twice a day to treat diabetes. Unripe fruits are eaten by children specially.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Uttarakhand</strong></td>
<td></td>
</tr>
<tr>
<td>41. Wildlife Institute of India campus, Dehradun</td>
<td>Seed and root are used against malarial fever, urinary disorder, vomiting, toothache and diarrhoea.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Manipur</strong></td>
<td></td>
</tr>
<tr>
<td>42. Local <em>Maibas</em> and elders of Konthoujam Lairembi, Mahabali, Langol Thongak Lairembi and Heingang Marjing sacred groves</td>
<td>Shoot, leaves and seeds are consumed orally to treat jaundice, vertigo and biliousness and to treat dog bite.</td>
</tr>
</tbody>
</table>

Table 2—Ethnomedical uses of *M. maderaspatana* among various cultures outside India

<table>
<thead>
<tr>
<th>Community/Locality</th>
<th>Ethnomedical uses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Africa</strong></td>
<td></td>
</tr>
<tr>
<td>1. The Yoruba ethnic community of South Nigeria, Berom, Hausa, Yoruba, Igbo, etc. ethnic groups of the Federal Republic of Nigeria</td>
<td>The herb is regarded as a preventive or a cure for òkà, a disease that affects childrens’ head. A decoction of the young shoots and leaves are used as an aperient, especially for children. Root is chewed to relieve facial neuralgia, toothache and other painful conditions. Seeds are used to induce perspiration.</td>
</tr>
<tr>
<td>2. Traditional medical practice of Tanganyika</td>
<td>Leaf-sap is used as a wound-dressing; leaves in poultice for burns and the sap is given to younger children to treat amoebiasis. Dried and powdered leaves are reported to be dusted over scabies and the plant-ash, mixed in castor oil, is rubbed over scarification and the temples to relieve headache.</td>
</tr>
<tr>
<td>3. The ethnic communities of Cayor</td>
<td>Leaves are prescribed for treating mental troubles.</td>
</tr>
<tr>
<td>4. Mossi, Bobo and other ethnic groups of Burkina Faso</td>
<td>Water boiled after adding the leaves is used to wash sick infants. Seeds are chewed or consumed in the form of a decoction.</td>
</tr>
<tr>
<td>5. Various ethnic groups of Senegal, <em>Fula of Dianguel</em> in Senegal</td>
<td>Fruit is used as a vermifuge. Ascribe magical properties to the fruit and in this sense use them as antidotes against poisons.</td>
</tr>
<tr>
<td><strong>Australia</strong></td>
<td></td>
</tr>
<tr>
<td>6. The indigenous aboriginal population of Central Australia</td>
<td>Whole plant is used as a general medicine and to relieve headache and skin sores and to treat sore eyes.</td>
</tr>
</tbody>
</table>

(Contd)
Atherosclerosis, apoptosis and HT has been fairly well established today. Based on the traditional knowledge of *M. maderaspatana*, Veeramani *et al.* have investigated the antihypertensive effect of the crude EtOH-leaf extract (CELE) on sham-operated and uninephrectomized DOCA-salt-induced hypertensive male albino Wistar rats. Their publication reports a significant increase in the systolic (SBP) and diastolic (DBP) blood pressures and mean arterial blood pressures (BP) in the DOCA-salt-induced hypertensive rodents after six-week injection. Oral treatment (p.o.) of CELE and standard nifedipine, once daily (q.d.) had significantly reduced the SBP and DBP and the effect has been more pronounced at 200 mg/kg body weight (bw) dose. Further, there has been no significant difference in the BP between the plant-drug treated and nifedipine (20 mg/kg bw) treated animals at the end of the six-week study period, according to the research findings.

As antioxidant

The effect of CELE on the antioxidant status in the sham-operated and DOCA salt-induced hypertensive rats has also been investigated by Veeramani *et al.* Lipid peroxidation (LP), initiated by RS, results in a number of secondary oxidation marker products, including malonaldehyde (MA). Among LP products that are used for antioxidant assays, MA is the most widely used one to evaluate the antioxidant capacity of substances in LP systems. MA-TBA (thiobarbituric acid) assay has become one of the popular assays for studies related to LP and is used widely to evaluate the antioxidant capacities of various natural products. However, TBA is not that specific and is capable of reacting with many different carbonyl compounds formed from LP. As a result, a more relevant parameter, the total carbonyl compounds reacting with TBA, called TBA-reacting substances (TBARS) has evolved. The administration of the leaf-extract to the DOCA-salt rats has been reported to cause significant reductions in the HT-elevated levels of the TBARS and lipid hydroperoxide in plasma, liver, kidney and heart tissues. It is claimed that the effect has been more pronounced and better realised at the administered dose of 200 mg/kg than 20 mg/kg bw of standard nifedipine. Further, the activities of the enzymatic antioxidants such as superoxide dismutase, catalase and glutathione peroxidase in the erythrocyte, liver, kidney and heart tissues (which have been significantly decreased among the DOCA-salt-hypertensive rats) have been substantially elevated. Again the effect has been realised better at the 200 mg/kg bw tested dose than the standard nifedipine. A similar effect has been reported in the levels of the non-enzymatic antioxidants such as vitamins C and E and reduced glutathione in the plasma and tissues. The authors have expressed that the phenolic phytochemicals that possess high antioxidant,
antihypertensive and antidiabetic activities and coumarin having varied pharmacological activities such as anticoagulant, hypotensive and antiinflammatory activities might be responsible for the observed activities. The leaf-extract is reported to contain 292.4 mg gallic acid equivalents of phenolics/100 g fresh leaf-material (FL). Flavonoids are the abundant phenolics of our diet and proven to possess an effect on antioxidant capacity, resulting in the protection against cardiovascular and other free radical-mediated diseases. A total of 247.1 mg quercetin equivalents of flavonoids/100 g FL, composed mainly of 7-O-β-D-glucopyranosyl-6-C-β-D-glucopyranosides of luteolin and apigenin, together with 6-C-β-D-glucopyranosides of apigenin and luteolin as well as their 8-C-β-D-glucopyranosyl isomers have been characterised from the leaves. These compounds have been reported to possess RS, including superoxide and nitric oxide, scavenging and metal chelating antioxidant capacities. 7-O-β-D-glucopyranosyl-6-C-β-D-glucopyranosylapigenin has been determined by HPLC to be the predominant polyphenol of the leaf, existing to the extent of 220.80 mg/100 g FL. The total leaf-antioxidant capacities have also been reported to be contributed by vitamins C and E, and carotenoids to the extent of 17.05, 0.19 and 0.81 mg/100 g FL, respectively.

Administration of 0.5% DMSO solutions of the chloroform fraction (CF), EAF and MF of the CELE (60 mg/kg bw, p.o. by intubation) had resulted in significant lowering of the SBP and DBP only among the EAF-treated rodents after six weeks. A significant inverse association between dietary phenolics and mortality from coronary heart disease is well established epidemiologically and hence the authors have claimed that the phenolics, especially the antihypertensive ferulic acid, could have contributed to the elicited antihypertensive property. Further, the EAF-treatment is reported to have re-established the salt-induced-metabolic-alterations in the levels of magnesium, copper and zinc in plasma, liver, kidney and heart tissues of the test-animals. It has also been noticed that in the HT-induced rats, the levels of serum sodium and chloride together with plasma epinephrine and norepinephrine had increased while potassium, total plasma nitrite-nitrate and L-arginine amounts had decreased. Treatment with EAF, as before, is recorded to have brought these parameters back to normalcy. It is speculated that stimulation of endothelin-1 (ET-1) production in vascular tissues is one of the factors that contribute to the development and/or maintenance of DOCA-salt-induced-HT. Endothelial nitric oxide synthase (eNOS) protein expression has been found to have significantly down-regulated in the heart and kidney while the ET-1 got up-regulated to similar magnitude in the kidney but to a lesser extent in heart of the HT-rats. Treatment with EAF had prevented the down-regulation of eNOS, and significantly down-regulated ET-1 protein expressions.

Hepatoprotective activity

The capacity of the aqueous extract of the aerial parts of M. maderaspatana to protect albino rat-liver from carbon tetachloride (CCl₄)-induced damages has been evaluated and reported in a series of articles by Tharbew et al. They have reported significant improvements in the CCl₄-mediated liver histopathology as well as serum levels of alanine aminotransferase (serum glutamic pyruvic transaminase-SGPT), aspartate aminotransferase (serum glutamic oxaloacetic transaminase-SGOT), alkaline phosphatase-ALP, aniline hydroxylase and p-aminopyrine-N-demethylase activities. Their work has, thus, provided a supportive evidence for the folkloric view of the plant as a good hepatotonic. Balaraman et al. have also noted a remarkable reduction in the levels of SGOT, SGPT and ALP of treated streptozotocin (STZ)-induced diabetic Sprague-Dawley rats. Phenobarbital-induced sleeping times in rats and kinetic enzyme studies had demonstrated that the properties elicited by the plant-drug treatment has been neither due to an induction of the drug metabolizing enzymes nor due to an alteration in the equilibrium constants of the enzymes.

The effect of the plant extract on the damage induced in freshly isolated rat hepatocytes by D-galactosamine and tert-butyl hydroperoxide (TBH) has also been investigated by Tharbew et al. According to them, on incubation of hepatocytes with galactosamine or TBH, in the presence of the plant extract, a significant dose-dependent protection against hepatocyte damage has been observed. The maximum protection has been recorded at a concentration of 500 µg/mL. At this concentration, the galactosamine-induced release of lactate dehydrogenase (LDH) and aspartate aminotransferase (AST) are reported to have got reduced by 40.7 and 37.7%, respectively, compared to the control. The TBH-induced LP (estimated from MA
production) is reported to have got decreased by 26.0% together with a 38.4 and 40.8% reductions in the release of cellular LDH and AST, respectively into the incubation medium. On post-treatment with the plant extract, the protective activity is claimed to have decreased with an increase in the time of exposure of the cells to either of the toxins. Such direct protective effects of the extract on hepatocytes have made the authors to favourably support the traditional use of this plant as an herbal remedy for liver diseases. The methanolic root extract (500 mg/kg, q.d, p.o., 21 d) has also been recorded to significantly decrease the elevated-SGOT, -SGPT and -ALP in alloxan-administered diabetic rats to normalcy after 21-days treatment. No significant difference between the normal control and diabetic control is reported from the study.

Immunomodulatory activity
Thabrew et al. have analysed the effects of the aqueous extract of the whole plant on the human immune system also. The extract has displayed strong anticomplement effects on both the classical and alternate pathways of the human complement system in vitro, as per the literature. According to them, the effects have been dose-dependent and most pronounced in the classical complement pathway assay. The extract also had exhibited a direct dose-dependent inhibition of luminol-induced chemiluminescence of human polymorphonuclear leukocytes upon stimulation with zymosan.

Antihyperglycaemic activity
Administration of EtOH-extract of M. maderaspatana (100 and 200 mg/kg bw, p.o.) to alloxan-induced diabetic male Wistar albino rats is reported to have decreased the blood glucose (BG) levels by 20.0 and 24.4%, respectively after 5 h of treatment, compared to the 31.8% decrease at 0.2 g/kg glibenclamide standard. No apparent hypoglycaemia has been observed among the normal rats in the study. On the other hand, no significant alteration in BG has been reported from a related study after the administration of 500 and 1000 mg/kg bw of an aqueous extract of the plant p.o. to STZ-induced diabetic albino rats in relation to the diabetic control. However, the authors have claimed that a dose of 2000 mg/kg could significantly decrease the BG in the diabetic rats. The histopathological assessment of the pancreas of the treated-rats is said to have demonstrated protective features against the STZ-induced cell damage, according to the paper. The concurrent treatment of STZ-induced diabetic Sprague-Dawley rats with M. maderaspatana EtOH-aerial parts for 14 days has been claimed to cause significant reduction in BG level and significant increase in glycogen formation. The increased glycogen-content in drug-treated experimental animals could have contributed to the decreased endogenous glucose output from the liver, as expressed by the authors.

Alloxan-induced diabetic Sprague rats, when subjected to EtOH and aqueous stem extracts treatment, are said to have exhibited significant hypoglycemic activity by increase in glucose uptake in L-6 skeletal muscle cells in vitro. At a concentration of 200 mg/kg bw, the extracts-treated rats in vivo is reported to significantly lower the serum glucose levels in the diabetic animals compared to the standard drug, glibenclamide (7 mg/kg). Methanolic root-extract treatment to alloxan-induced diabetic rats was capable of correcting the metabolic deviation in the BG as per a report. There has been no significant difference among the normal-control and diabetic-control during the period of study, as reported.

Oral glucose tolerance test, on overnight-fasted male C57BL/6 mice, to determine the effect of the drug (200 mg/kg, p.o., EtOH-extract of the aerial parts of M. maderaspatana) on insulin and β-cell functions of pancreas at glucose load under normal condition has resulted in marked alteration in the glucose tolerance, equivalent to 300 mg/kg, p.o. of the standard metformin. In yet another protocol, the ability of the EtOH-extract of the aerial parts of the plant to inhibit glucose absorption through intestine has been analysed. The estimations of the glucose contents of the everted jejunal sacs have revealed dose-response variations in glucose absorption. The insulinitropic effect has also been assessed using isolated pancreatic islets and insulinoma cell line, INS-1E. Notable effect on glucose-induced-insulin secretion has been reported from the isolated mice splenic pancreatic islets. Similar effect has also been significantly exerted on the insulin secretion from INS-IG insulinoma cell clusters. The authors are also of the opinion that the observed antidiabetic activity of M. maderaspatana might be due to its high flavonoid content, as these compounds have been proved to protect cells from oxidative stress-mediated cell injuries and exert a remarkably broad array of beneficial biological implications on humans.
Pancreatic α-amylase and α-glucosidase are the key enzymes of the digestive system that catalyze the hydrolysis of starch, glycogen and various oligosaccharides to the readily available sugars for intestinal absorption. α-Glucosidase has been recognized as a therapeutic target for modulation of postprandial hyperglycemia, which is the earliest metabolic abnormality to occur in type 2 diabetes. Inhibition of α-amylase and α-glucosidase activities in the digestive tract of humans is considered to be effective in controlling diabetes, since the inhibition can reduce the products of starch decomposition. The EtOH-extract of the whole plant has been reported to exhibit α-amylase and α-glucosidase inhibitory activities. The authors have attributed the observed activities to the flavonoids and other phenolics and terpenoids, elaborated in the drug species.

Antihyperlipidemic activity

Hyperlipidemia is the primary risk factor of coronary and atherosclerotic heart diseases and is characterized by elevations in plasma total cholesterol (TC), triglycerides (TG), low density (LDL) and very low density liprotein-cholesterol (VLDL) and depression in high-density lipoprotein (HDL). Administration of the aqueous extract of dried aerial parts of M. maderaspatana (2 g/kg, p.o.) concomitantly with high-fat diet to albino rats of either sex (Charles Foster strain) for 7 weeks had displayed significant reduction in the lipid level, according to one literature. A significant decrease has also been realised in the bw, TG, TC, LDL and VLDL, in addition to improvements in HDL and hepatic lipid peroxide (LPO). However, the authors have not observed significant changes in the serum atherogenic index. Histological evaluation of the hepatic tissue of the rat liver, treated with the aqueous extract, has revealed only micro vesicular fatty changes as against the marked degenerative and fatty changes in the high fat diet-fed animals.

STZ-induced diabetic Sprague-Dawley rats, concurrently treated with 100 and 200 mg/kg bw, p.o. of EtOH-aerial parts of the plant for 14 days, has been reported to have recovered from the altered biochemical parameters and bw. The significantly increased plasma TC, TG and LDL levels have been reported to get reversed to near normal magnitudes. Similarly, the decreased HDL during diabetes has been brought back to normalcy. In another study, STZ-induced diabetic male albino rats (Charles Foster strain), treated with the aqueous extract of the whole dried plant (2 g/kg, p.o., 7 d) is also reported to have caused significant lowering of serum TC and LPO and also hepatic LPO parameters in diabetic rats. In an experiment, 21-days methanolic root-extract-treated alloxan-induced diabetic male Wistar rats have been reported to have exhibited decreased levels of the diabetic-related elevations in TC, TG, phospholipids (PL), LDL and VLDL parameters. An increase in the lowered HDL-level has also been concomitantly reported. A very recent study has revealed that CELE treatment (200 mg/kg, p.o., q.d., 6 w) to DOCA-salt-hypertensive rats had normalised the TG, TC, LDL, HDL, VLDL, PL and free fatty acid (FFA) parameters of plasma and tissues (liver, kidney and heart) among the salt-induced-hypertensive animals. Histopathology of the liver, kidney and heart of the animals had further revealed favourable reductions in the DOCA-salt-induced damages.

In vitro antiplatelet aggregation activity

HT is a major risk factor for stroke/myocardial infarction as expression of the atherogenic processes and platelets play a fundamental role. The equilibrium between pro-aggregating and anti-aggregating factors that normally prevails under physiological conditions gets disturbed during pathological situations and pro-aggregating factors tend to dominate. A number of phytoconstituents tend to inhibit platelet aggregation and re-establish the broken equilibrium. The in vitro antiplatelet aggregating activity of the HF, CF, EAF and MF fractions of M. maderaspatana has been studied using platelet-rich plasma. EAF has been reported to have exhibited a dose-dependent activity whereas HF and MF had demonstrated the maximum activity only at 400 µg/mL and CF had no protection against platelet aggregation, according to the authors. However, the inhibition of platelet aggregation has been reported to be only 50% of the standard tested drug, aspirin (100 µg/mL). Flavonoids appear to inhibit platelet aggregation by mediating increase in cyclic adenosine monophosphate levels of the platelets by either stimulation of adenylate cyclase or inhibition of cyclic adenosine monophosphate phosphodiesterase activity.

Antimicrobial activity

It is well understood that the plant kingdom synthesise a myriad of bioactive molecules in response to environmental stimuli and a number of
these can inhibit bacterial and fungal proliferation. Palombo & Semple have attempted to establish the antimicrobial potential of *M. maderaspatana*, which is utilized by the indigenous Aborigins of Australia, against *Bacillus cereus*, *Enterococcus faecalis*, *Staphylococcus aureus*, *Streptococcus pyogenes*, *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Salmonella typhimurium* but have failed. On the other hand, Parekh & Chanda have reported to have observed mild activity against *K. pneumonia* for the EtOH-extract of the fresh plant but not against *S. aureus*, *S. epidermidis* and *S. subflava*. However, 10 µg/mL DMSO solutions of the PEF and MF have been reported to be active against *S. aureus*, *B. subtilis*, *P. aeruginosa* and *E. coli*. Both the extracts have been found to have prominent activities against the fungal strains, *Candida tropicalis* and *Trichophyton rubrum* (100µg/mL DMSO solutions). Similar trends have been reported for the PEF and MF against *S. aureus*, *B. subtilis*, *P. aeruginosa* and *E. coli*. Both the collections have exhibited negligible activities against *K. pneumonia* and *E. coli* and only MF and not CF and AF of Sri Lankan specimen is reported to be active. The MF of the Sri Lankan specimen had also exhibited substantial activity against *E. coli* than its Indian counterpart. Against *P. aeruginosa*, the Indian specimen is recorded to be mildly active but not the Sri Lankan one. The HF, EAF and MF of both the sample specimens have been recorded to be comparably potant against *S. pyogenes*, and the CF of the Sri Lankan specimen had demonstrated well pronounced action than its Indian counterpart. According to Sagayaraj et al, the leaf and stem EtOH-extracts have inhibited *E. coli*, *K. pneumoniae*, *Pseudomonas putida*, *Proteus mirabilis*, *S. aureus*, *Aeromonas hydrophila*, *Rhizobus sp.* and *Aspergillus flavus* better than CF and AF. Chitravadivu et al., have extracted PEF, HF and EtOH-fractions from commercial *Kabha marundhu laehtium* and subjected them to antimicrobial evaluations. Significant activities for the EtOH and PEF extracts and moderate inhibitions by HF and the aqueous fractions against *Staphylococcus aureus*, *B. subtilis*, *E. coli*, *P. aeruginosa* and *C. albicans* have been reported. A recent study has reported that *S. aureus*, *K. pneumonia*, *E. coli* and *P. aeruginosa* are sensitive and *S. typhimurium* resistant to 750 µg/mL EtOH-extract of the aerial parts of *M. maderaspatana*.

**Antiulcer activity**
Ulcers, particularly, gastric ulcer is yet another health hazard prevailing common among the modern folks. The pathophysiology of gastric ulceration is generally focused on the imbalance between the aggressive and the protective factors in the stomach, such as acid-pepsin secretion, mucosal barrier, mucus secretion, blood flow, cellular regeneration, prostaglandins and epidermal growth factors. RS, especially hydroxyl radical, is believed to play a major role in causing oxidative damage of mucosa in all types of ulcers. Stress-induced anti-ulcer activity of the crude aqueous suspension of the dried *M. maderaspatana* leaf has been investigated on male albino rats of Wistar strain. Upon starvation, the biochemical parameters, viz. the volume of the gastric content, gastric pH, ulcer index, total acidity, free acidity and MA have been reported to have elevated in the stressed animals. The serum MA has also been reported to have increased while the serum reduced glutathione has been claimed to have depressed. Treatment with only 500 mg/kg via an intragastric tube for 7 days has been recorded to have brought back all the observed parameters close to those of the control animals.

**Anxiolytic activity**
A feeling of apprehension, uncertainty or tension stemming from the anticipation of imagined or unreal threat characterises human anxiety. It has been conceptualized into two subscales: one for measurement of trait anxiety and the other for measurement of state anxiety. Existing in a transitory emotional state that varies in intensity and fluctuates over time is classed as state anxiety. Trait anxiety refers to a condition of stable susceptibility or a proneness to experience state anxiety frequently. A very recent study has succeeded in evaluating the anxiolytic activity of the hydro-alcoholic (1:1) extract of the leaves of *M. maderaspatana* among experimental rodents that have been subjected to state anxiety conditions. A state of anxiety arises in animals when they are exposed to unfamiliar conditions that create fear. The anxiolytic potency of the test plant has been evaluated using (i) the
conventional elevated plus maze animal model, which is considered as one of the most widely validated tests for assaying sedative and anxiolytic drugs, by using normally healthy Wister strain rats, and (ii) socio-behavioural deficit test, which has been carried out using mice of both sexes. Administration of 150 mg/kg, p.o. of leaf-extract is reported in their paper to significantly increase the number of entries and the time spent in the two oppositely aligned open arms of the plus maze, when compared to the control group. The behavioural pattern has been described similar to that of the treatment using standard diazepam (1 mg/kg bw, intraperitoneal). In the socio-behavioural deficit study also, *M. maderaspatana* leaf-extract (150 mg/kg bw, p.o.) had significantly reduced the escape attempts of the mice, placed under an inverted beaker, when compared with the control. Reductions to a similar extent have been reported with diazepam-treatment also. Quoting previous reports, the authors have indicated that flavonoids, saponins and tannins, which have exhibited significant activities in those studies against many CNS disorders, might possibly contribute to the anxiolytic activity of the extract realised in their studies also.

**Local anaesthetic activity**

Local anaesthetic activity of EtOH and aqueous extracts of the air-dried leaves of *M. maderaspatana* has been evaluated in healthy frogs of either sex, using nerve block anaesthesia method\(^1\). The EtOH-extract has been reported to have exhibited the maximum activity and the effect had lasted longer among the tested groups in vivo.

**Pharmacological Profile—Clinical investigations on human subjects**

**Antihypertensive activity**

Literature cites the practice of the Siddha practitioners of Tamil Nadu to treat hypertension (HT) using decoctions of the leaves of *M. maderaspatana*\(^2\). Treatment (two teaspoons dried and finely powdered leaves, suspended in 50 mL hot water for 5 min and cloth-strained, twice daily, 45 days) to mild-to-moderate hypertensive (13 men and 12 women, mean age 58±9.0 y, SBP ≥ 140 mm, DBP ≥ 90 mm Hg) and normotensive (14 men and 11 women, 48±8.0 years) volunteers could significantly reduce SBP, DBP and pulse pressure as well as body weight and BMI in patients with HT, after leaf-tea treatment for 45 days\(^3\). Saturated fatty acid content of erythrocytes had been reduced significantly, while mono-unsaturated fatty acid and polyunsaturated fatty acid contents as well as membrane fluidity of erythrocytes have been improved in patients with HT, who were treated. Membrane fluidity in the study has been assessed using spin labelling techniques and electron paramagnetic resonance spectroscopy\(^4\).

**Anti-inflammatory activity in rheumatoid arthritis**

Treatment (2.5 g of finely powdered and shade-dried aerial parts of *M. maderaspatana*, p.o., thrice daily with warm water, 6 weeks) to 12 males and 18 females with rheumatoid arthritis has been claimed to significantly improve the clinical parameters, viz., numbers of painful and swollen joints, Ritchie articular index (RAI), swelling score, visual analogue scale, walking time, morning stiffness and grip strength are suggestive of anti-inflammatory activity\(^5\). Laboratory parameters (E.S.R and haemoglobin) have also been recorded to have improved. The treatment has also reduced fever and anxiety and has improved the appetite and had not produced any adverse effects such as nausea or vomiting, as observed by the investigators. 16.7, 56.7 and 26.6% of the subjects have respectively shown poor, good and excellent response to the treatment, as reported in the paper. The analgesic and antipyretic activities of the extract has been recognized by the authors from the reduction in visual analogue scale, number of tender joints and fever. Consequently, the crude plant drug has been endowed with anti-inflammatory and antirheumatic potentials.

**Mosquito ovicidal, larvicidal and repellent potentials**

Mosquito ovicidal activities of the benzene fraction (BF), AF, EAF, HF and MF of *M. maderaspatana*...
leaves have been studied against the important human vector mosquito, *Aedes aegypti*. 100% egg mortality has been reported at 240 ppm for all the five extracts during the 48 h post treatment study period. The EAF, HF, AF and MF have been recorded to be potent at concentrations above 160 ppm. MF has been assessed to be the most active above 120 ppm. Similarly, an isopropanolic solution of the crude AF, BF, EAF, HF and MF applied on the dorsal side of the skin of the volunteers’ arms at a concentration of 3.0 mg/cm² has been claimed to provide 100% protection up to 80, 100, 120, 120 and 140 min, respectively against *A. aegypti* bites. The experiment has been conducted for five times during the day time from 7:00 h to 17:00 h. and no skin irritation due to the plant extract has been reported in the study. However, MF of the plant collected from Kanyakumari coast of India had failed to demonstrate significant larvicidal activity against *Culex quinquefasciatus* mosquito up to a concentration of 100 mg/L.

**Phytoremediation potential**

The plant is reported to be one of the nine most promising species that may be useful for pollution control and dumped waste solid management purpose in the Midnapore and Kharagpur municipalities of Paschim Medinipur district of West Bengal, India. The study was conducted on 73 plant species that naturally grow on the dumped solid waste in different seasons. They absorb quickly the waste and decaying organic matters for their growth and thereby biodegrade the mass. Hence, the authors have suggested *M. maderaspatana* and eight other plant species to be the promising ones in solid waste management and environmental pollution control.

**Propagation/Regeneration strategies**

Increasing acceptance of biological diversity as an important focus for human wellbeing is a growing concern of the recent decades. Wild plants have enormous endemic, cultural, economical and aesthetic importance. They provide food, medicine, fuel, clothing and shelter to a variety of population. Unfortunately, a large number of these plant species are under threat because of habitat modification, over exploitation, pollution, desertification, invasive alien species and climate change. Decades of injudicious human activities involving extensive expansion of residential areas and related developments have significantly resulted in irreversible and potentially detrimental changes to the natural environment. Conservation of natural resources in order to maintain the structure and functions of the eco-system and to ensure tangible benefits has therefore become a matter of concern to the whole world today.

Effective protocols have been developed for the *in vitro* regeneration of *M. maderaspatana* in liquid and solid culture systems. Organogenesis has been achieved from liquid culture calluses derived from leaf and petiole explants of mature plants. Organogenic calluses have been induced from both leaf and petiole explants on Murashige and Skoog (MS) liquid medium containing (i) 2,4-dichlorophenoxyacetic acid (2,4-D) and thidiazuron (TDZ) and (ii) 2,4-D and benzyladenine (BA). Adventitious shoot regeneration has been achieved on MS medium supplemented with BA, TDZ, coconut water and glutamine from leaf-derived calluses. Petiole-derived calluses have produced adventitious shoots on MS medium fortified with BA, TDZ, coconut water (CW) and glutamine. Elongation of shoots has been reported to occur in MS medium with gibberellic acid (GA₃). Regenerated shoots (2-3 cm in length) had rooted and hardened, when they have been transferred to 1/2-MS medium supplemented with indole-3-butyric acid (IBA) followed by garden soil, vermiculate, and sand mixture. The elongated shoots (4-5 cm in length) have been exposed simultaneously for rooting as well as hardening in moistened garden soil, vermiculate and sand mixture. Subsequently, the plants have been reported to have successfully established in the field with varying survival rates, depending on the seasonal variations.

In another micro-propagation system, prolific shoot regeneration have been achieved on an enriched MS medium containing watermelon juice, sucrose and agar, supplemented with BA, CW and casein hydrolysate (CH). A higher number of shoots (mean = 32.7) has been observed by the investigators on an enriched MS medium supplemented with BA, CW and CH. The regenerated shoots (40-50 mm length), after dipping in indole-3-butyric acid (IBA) for 15 min, have been transplanted into plastic pots containing a mixture of vermiculite and sand to induce rooting. As a result, a mean of 10.4 roots per shoot have been realised. The elongated shoots (4-5 cm in length) had rooted and hardened, when they have been transferred to 1/2-MS medium supplemented with BA, TDZ, coconut water (CW) and glutamine. Elongation of shoots has been reported to occur in MS medium with gibberellic acid (GA₃). Regenerated shoots (2-3 cm in length) had rooted and hardened, when they have been transferred to 1/2-MS medium supplemented with indole-3-butyric acid (IBA) followed by garden soil, vermiculate, and sand mixture. The elongated shoots (4-5 cm in length) have been exposed simultaneously for rooting as well as hardening in moistened garden soil, vermiculate and sand mixture. Subsequently, the plants have been reported to have successfully established in the field with varying survival rates, depending on the seasonal variations.

In another micro-propagation system, prolific shoot regeneration have been achieved on an enriched MS medium containing watermelon juice, sucrose and agar, supplemented with BA, CW and casein hydrolysate (CH). A higher number of shoots (mean = 32.7) has been observed by the investigators on an enriched MS medium supplemented with BA, CW and CH. The regenerated shoots (40-50 mm length), after dipping in indole-3-butyric acid (IBA) for 15 min, have been transplanted into plastic pots containing a mixture of vermiculite and sand to induce rooting. As a result, a mean of 10.4 roots per shoot have been realised. The elongated shoots (4-5 cm in length) had rooted and hardened, when they have been transferred to 1/2-MS medium supplemented with BA, TDZ, coconut water (CW) and glutamine. Elongation of shoots has been reported to occur in MS medium with gibberellic acid (GA₃). Regenerated shoots (2-3 cm in length) had rooted and hardened, when they have been transferred to 1/2-MS medium supplemented with indole-3-butyric acid (IBA) followed by garden soil, vermiculate, and sand mixture. The elongated shoots (4-5 cm in length) have been exposed simultaneously for rooting as well as hardening in moistened garden soil, vermiculate and sand mixture. Subsequently, the plants have been reported to have successfully established in the field with varying survival rates, depending on the seasonal variations.
In yet another protocol, cotyledon explants isolated from in vitro germinated seedlings (5-6 days old) have been cultured on MS medium containing different concentrations of BA alone/in combination with indole-3-acetic acid (IAA)\(^{127}\). Cotyledon explants cultured on medium containing BA and IAA had induced a significantly higher number of multiple shoots (9.00 ± 0.60) with increased mean shoot length (2.70 ± 0.10) within 5 week of culture. Leaf segments from in vitro grown plants (20 days) have been cultured on MS medium with different concentrations of BA alone/together with IAA. Maximum number of shoots (10 ± 0.75) with increased mean shoot length (2.90 ± 0.12) in this experiment have been obtained directly from leaf explants (without intervening callus phase) using a combination of BA and IAA within 5 weeks of culture. Inclusion of IAA to MS medium with BA has been reported to have triggered a high frequency of regeneration from leaf and cotyledon explants. Elongation of regenerated shoots had occurred when cotyledon cultures (3 weeks) have been transferred to MS basal medium. Leaf cultures with emerging shoots have then been sub-cultured onto the same treatment medium for further elongation. The elongated shoots (2-3 cm) have subsequently been excised and rooted on MS medium, supplemented with IBA. Rooted plants have then been acclimatized in the greenhouse with a 70% survival rate.

A very recent in vitro propagation study using leaf, node, internode and shoot tip explants is reported to have yielded the following results\(^{129}\). The leaf-explant is said to have produced callus effectively in the MS medium supplemented with BAP and 1-naphthaleneacetic acid (NAA) while the nodal-explant has yielded an higher amount of direct shoots (89%) in the MS medium containing the growth regulators, BAP and NAA. The leaf-derived calluses have been claimed to have yielded shoots effectively (88%) when sub-cultured onto the MS medium with BAP. Similarly, the percentage of node for shooting has been higher (85%) in the MS medium fortified with BAP and GA\(_3\). The per cent response of leaf-callus derived shoots for rooting has been greater (87%) when sub-cultured onto the MS medium supplemented with IBA alone while the node derived shoots have been 83% when sub-cultured on MS medium fortified with IBA and IAA.

**Conclusion**

*M. maderaspatana* is an indigenous leafy vegetable possessing a myriad of health care potentials, spanning from protection against the widely prevalent HT, diabetes and rheumatoid arthritis to the less dominant anticonvulsant\(^{130}\). Oxidative stress, arising out of the imbalance in the oxidant-antioxidant status of an organism, has currently come to occupy an amazingly central role in addressing the pathogenesis of a wide spectrum of chronic and age related human ailments, including ageing. The potent *in vitro* and *in vivo* antioxidant capacities, which have emerged from studies of the recent past, speculate the role of the antioxidant phytometabolites as potential contributors to the ethnopharmacological claims of the taxon. Though the *in vitro* antioxidant capacities of these chemical classes are fairly well established, the outcomes of several *in vivo* studies continue to be inconclusive. Consequently, adequately programmed strategies to address the synergistic actions of the various classes of secondary metabolites, elaborated in *M. maderaspatana*, and may help to establish its functional food value.

**References**

9. Kala CP, Prioritization of cultivated and wild edibles by local people in the Uttarakhand hills of Indian Himalaya, *Indian J Trad Knowledge*, 2007, 6 (1), 239-244.
Revathi P and Parimalazhagan T, Traditional knowledge on medicinal plants used by the Irula tribe of Hasanur hills, Erode district, Tamil Nadu, India, *Ethnobot Leaflets*, 2010, **13**, 136-60.


50 Mythu C, Ayyanan M, Raja N and Ignacimuthu S, Medicinal plants used by traditional healers in Kancheepuram district of Tamil Nadu, India, *J Ethnobiol Ethanmed*, 2006, **4**, 2, 43.


78 Manandhar NP, Ethnobotanical census on herbal medicine of Banke district, *Nepal, CNAS*, 1998, **25** (1), 57-63.


PETRUS: ETHNOBOTANICAL AND PHARMACOLOGICAL PROFILE OF MUKIA MADERASPATANA

84 Algasoumi SI, Isolation and chemical structure elucidation of hepatoprotective constituents from plants used in traditional medicine in Saudi Arabia, Ph. D. Thesis, King Saud University, Kingdom of Saudi Arabia, 2007, p. 29.
95 Jayatilaka KAPW, Thabrew MI and Perera DBJ, Effect of Melothria maderaspatana on carbon tetrachloride-induced changes in rat hepatic microsomal drug-metabolizing enzyme activity, J Ethnopharmacol, 1990, 30 (1), 97-105.


