MEDICINAL PLANTS REMEDY FOR WATER-BORNE DISEASES IN RURAL AND REMOTE AREAS OF UTTARAKHAND: A REVIEW

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Abstract

Medicinal plants study has emerged as a new topic of interest which unravels the therapeutic potential of different species of plant of therapeutic interest. Uttarakhand state is the niche as well as the repository of diverse medicinal plants that have an immense role in the pharmaceutical industry and can help in sustaining the livelihood of people living in this area in the near future. Approximately, 300 plant species have been recorded from the Uttarakhand, illustrating the richness of herbal plant in the state and empowering the herbal-dependent industry in sub-Himalayan region. The potential medicinal value lies in all the parts of plants like root, shoot, fruits and leaves for treating various illnesses. Thus, there is urgent need to record the traditional knowledge about aromatic and medicinal plants as they are on the verge of extinction. Therefore, present study focuses on collecting the information about medicinal plants used in traditional medical system by the natives of Uttarakhand, India for curing the different ailments of water-borne and role of government and private sector in conserving this rich reservoir of medicinal plants.

Key words: Medicinal plants, Conservation, Healthcare, Water-borne diseases, Uttarakhand.

Introduction

Almost every civilization has the history of using medicinal plants and been the subject of interest since medieval times. Many different therapeutic plants are used in customary Indian system of the drug for the production of Ayurveda, Siddha and Unani medicine. The curative uses of plants have been well-documented in ancient Rigveda (1500-400BC) (Hassan et al., 2018). India is a fortunate place comprising medicinal diversity at all the levels of biodiversity like species, habitat and genetic diversity. Approximately, 4,80,000 different plants have been discovered worldwide and out of which 28,187 plant are medicinal plants. (Pullaiah et al., 2015, SOTWP, 2017). From India, almost 9,500 plant species have been found to have medicinal value (Chowti et al., 2018).

Because of diverse climatic condition as well as the geographical region, Uttarakhand, youngest mountain state of India has rich biodiversity of plant species that can empower and become the sustain source of revenue for hilly people in coming time. This state is surrounded by peaks of the Himalayas ranging from Nanda Devi (7817m) to the sub-tropical Terai region (Prakash, 2015). Thus, this place is also stated as “Dev Bhoomi” (Kumar et al., 2018). Recently, Database named UMPDB (Uttarakhand Medicinal Plants Databases) has been developed which affirm that state encompasses 1127 medicinal plant species which are the member of 153 plant families (Kumar et al., 2018).

According to the available census, state has the availability of drinking water (58.3%) within premise, premises without toilet facility (34.2%) and about 33.1% people use the open toilet (NHP, 2018). According to 2019 IDSP (Integrated Disease Surveillance Program) reports 1099 cases of acute diarrhoea with 5 deaths, 27 cases of cholera, 138 cases of Hepatitis E virus (HEV), 81 cases of Hepatitis A virus (HAV), 75 cases of combined hepatitis A & E with 1 death, 222 cases of suspected hepatitis, 55 cases of jaundice and 50 cases of typhoid have been recorded and illustrated in table 1 (IDSP, 2019).

On surveying the 8 villages of district Dehradun, highest numbers of diarrhoea patients (47.9%) were belonging to age below three years. Therefore, poor hygiene and...
People living in the hilly area of Uttarakhand gets affected worst and lack the access to quality treatment, due to the shortage of paramedical staff and doctors in the rural area. Moreover, health facilities available in this area are not operational (The Tribune, 2016). In this state insufficient number of doctors provide the medical care as they have to look after 70 percent of population. On the other hand, a large number of doctors are concentrated in urban areas like Dehradun, Haldwani, Haridwar and Udham Singh Naga (The Tribune, 2016).

A survey conducted to evaluate financial burden of out-of-pocket (OOP) expenditures on health care (primary) in hilly areas reported that OOP expenditure was 509-673.1 INR whereas the average family earns 11718.5 INR (Gupta et al., 2017). On the other hand, Van Gujjars community of Nainital, Udham Singh Nagar and Pauri lacks any access to health care facilities (Hussain et al., 2016). Therefore, present review highlights and underlines the importance of medicinal plants knowledge among the people of rural and remote region used for the treatment of water-borne diseases in the Uttarakhand, India.

### Plant families contributing to curing water-borne problems

On refereeing the articles, books, research paper and newspaper for literature survey were found 84 families of plant that were involve in treating the water-borne illness. The major contribution was shown by Fabaceae family (15 species) followed by Asteraceae (11 species), Euphorbiaceae (9 species), Rubiaceae, Rutaceae, Rosaceae and Solanaceae having 7 species each. Survey studies conducted by researchers of different regions of Uttarakhand on diverse medicinal plants have been enlisted in table 2 (Sharma et al., 2012, Gairola et al., 2013, Rawat et al., 2013, Kapkoti et al., 2014, Upreti et al., 2009, Kumar et al., 2011, Prakash, 2015, Bhat et al., 2013, Kumar et al., 2011, Chandra et al., 2013, Mathur and Joshi, 2013, Dangwal et al., 2010, Phondani, 2011, Kumari et al., 2011, Mehra et al., 2014, Pandey et al., 2017, Dangwal et al., 2011, Sharma et al., 2011, Dangwal and Sharma, 2011, Rana et al., 2013, Semwal et al., 2010, Mathur and Joshi, 2012, Kumar and Pandey, 2015, Kumari et al., 2012, Sharma et al., 2017, Singh and Attri, 2014, Singh et al., 2017, Gaur and Sharma, 2011, Malik et al., 2015). The contribution of different plant parts has been illustrated in fig. 1 having medicinal importance.

### Indigenous knowledge among villagers and tribal people

As the conventional therapeutic practices are the main human services available in numerous provincial
Table 2: Plants for the treatment of Water-borne Diseases in Uttarakhand.

<table>
<thead>
<tr>
<th>Name of the plant species</th>
<th>Family</th>
<th>Local names</th>
<th>Plant parts used</th>
<th>Ailments treated</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Aloe vera</em> (L.) Burn f.</td>
<td>Lilliaceae</td>
<td>Banskyuda</td>
<td>Leaves</td>
<td>jaundice, dysentery</td>
<td>Sharma <em>et al.</em>, 2012; Gairola <em>et al.</em>, 2013; Mehra <em>et al.</em>, 2014</td>
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<tr>
<td><em>Argemone mexicana</em> L.</td>
<td>Papaveraceae</td>
<td>Pili Katili, Pauns, Satyanasi</td>
<td>Latex, Whole Plant</td>
<td>jaundice</td>
<td>Sharma <em>et al.</em>, 2012; Mathur and Joshi, 2013</td>
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<tr>
<td><em>Centella asiatica</em> (L.) Urb.</td>
<td>Apiaceae</td>
<td>Bimi, Brahmi</td>
<td>Leaves, Whole Plant</td>
<td>jaundice, dysentery, diarrhoea, cholera</td>
<td>Sharma <em>et al.</em>, 2012; Pandey <em>et al.</em>, 2017; Singh and Attri, 2014</td>
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<tr>
<td><em>Eclipta prostrata</em> (L.) L.</td>
<td>Asteraceae</td>
<td>Bhangra, Mokchand</td>
<td>Leaves, Whole Plant</td>
<td>jaundice</td>
<td>Sharma <em>et al.</em>, 2012; Mathur and Joshi, 2013</td>
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<tr>
<td><em>Glycosmis pentaphylla</em> (Retz.) DC</td>
<td>Rutaceae</td>
<td>Pillu</td>
<td>Leaves</td>
<td>jaundice</td>
<td>Sharma <em>et al.</em>, 2012</td>
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<tr>
<td><em>Haldina cordifolia</em> (Roxb.) Ridsdale</td>
<td>Rubiaceae</td>
<td>Haldu</td>
<td>Bark</td>
<td>jaundice</td>
<td>Sharma <em>et al.</em>, 2012</td>
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<td><em>Lawsonia inermis</em> L.</td>
<td>Lythraceae</td>
<td>Mehndi</td>
<td>Roots</td>
<td>jaundice</td>
<td>Sharma <em>et al.</em>, 2012</td>
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<td><em>Momordica charantia</em> L.</td>
<td>Cucurbitaceae</td>
<td>Karela</td>
<td>Fruits</td>
<td>jaundice</td>
<td>Sharma <em>et al.</em>, 2012; Singh and Attri, 2014</td>
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<td><em>Physalis divaricata</em> D. Don</td>
<td>Solanaceae</td>
<td>Bhambholan</td>
<td>Roots</td>
<td>jaundice</td>
<td>Sharma <em>et al.</em>, 2012</td>
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<tr>
<td><em>Vitex negundo</em> L.</td>
<td>Verbenaceae</td>
<td>Sambhalu</td>
<td>Leaves, Whole Plant, Flowers</td>
<td>jaundice, dysentery, diarrhoea</td>
<td>Sharma <em>et al.</em>, 2012; Gairola <em>et al.</em>, 2013</td>
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<td><em>Amaranthus spinosus</em> L.</td>
<td>Amaranthaceae</td>
<td>Chaleri</td>
<td>Fruits</td>
<td>jaundice</td>
<td>Sharma <em>et al.</em>, 2012</td>
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<tr>
<td><em>Andrographis paniculata</em> (Burn. F.) Nees</td>
<td>Acanthaceae</td>
<td>Mamegh, Kalmedh, Kiryat</td>
<td>Leaves, Whole Plant</td>
<td>jaundice, dysentery</td>
<td>Sharma <em>et al.</em>, 2012; Mathur and Joshi, 2013</td>
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<tr>
<td>Plant Name</td>
<td>Family</td>
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<td>Condition</td>
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<td>Averrhoa carambola L.</td>
<td>Averrhoaceae</td>
<td>Fruits</td>
<td>jaundice</td>
<td>Sharma et al., 2012</td>
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<td>Benincasa hispida (Thunb) Cogn.</td>
<td>Cucurbitaceae</td>
<td>Kumara</td>
<td>Fruits</td>
<td>jaundice, cholera, Prakash, 2015; Sharma et al., 2011</td>
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<tr>
<td>Cajanus cajan (L.) Millsp</td>
<td>Fabaceae</td>
<td>Rahar, Arhar</td>
<td>Leaves</td>
<td>jaundice, dysentery, diarrhoea, Sharma et al., 2012; Gairola et al., 2013; Dangwal and Sharma, 2011</td>
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<tr>
<td>Cassia fistula (Thunb) Cogn.</td>
<td>Caesalpiniaceae</td>
<td>Karangal, Amaltas, Simar, Pari</td>
<td>Fruits, Leaves</td>
<td>jaundice, dysentery, diarrhoea, Sharma et al., 2012; Gairola et al., 2013; Kumari et al., 2011; Pandey et al., 2017</td>
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<tr>
<td>Cissampelos pareira L.</td>
<td>Menispermaceae</td>
<td>Paadha /Simrubel, Jaljamini, Pari</td>
<td>Leaves, Whole Plant, Roots</td>
<td>jaundice, dysentery, diarrhoea, Sharma et al., 2012; Gairola et al., 2013; Kumari et al., 2011; Pandey et al., 2017</td>
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<td>Cuscuta reflexa Roxb.</td>
<td>Cuscutaceae</td>
<td>Andarbel, Sarai-Babiya</td>
<td>Whole Plant, Seeds</td>
<td>jaundice, Sharma et al., 2012</td>
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<td>Cynodon dactylon (L.) Pers.</td>
<td>Poaceae</td>
<td>Dhoob, Dubghass, Dubar</td>
<td>Leaves, Whole Plant, Stems</td>
<td>jaundice, dysentery, diarrhoea, Sharma et al., 2012; Gairola et al., 2013; Pandey et al., 2017; Senwal et al., 2010; Mathur and Joshi, 2012; Singh and Attri, 2014</td>
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<td>Ehretia laevis Roxb.</td>
<td>Ehretiaceae</td>
<td>Chamror /Chamrod</td>
<td>Seeds</td>
<td>jaundice, Sharma et al., 2012</td>
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<td>Ficus religiosa L.</td>
<td>Moraceae</td>
<td>Badh, Pipal</td>
<td>Bark, Leaves, Fruits</td>
<td>jaundice, diarrhoea, Sharma et al., 2012; Singh and Attri, 2014</td>
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<td>Mangifera indica L.</td>
<td>Anacardiaceae</td>
<td>Amm</td>
<td>Bark, Leaves, Stems, Seeds</td>
<td>jaundice, dysentery, diarrhoea, Sharma et al., 2012; Singh and Attri, 2014; Singh et al., 2017</td>
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<td>Ocimum americanum L.</td>
<td>Lamiaceae</td>
<td>Tulsa</td>
<td>Whole Plant</td>
<td>jaundice, Sharma et al., 2012</td>
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<td>Oxalis corniculata L.</td>
<td>Oxalidaceae</td>
<td>Khati amli, Amlolo, Amrul, Anboti, Chalmori, Chilmora, Tinpatiya</td>
<td>Leaves, Whole Plant</td>
<td>jaundice, dysentery, diarrhoea, Sharma et al., 2012; Mathur and Joshi, 2013; Kumari et al., 2011; Singh and Attri, 2014</td>
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<td>Phyllanthus emblica</td>
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<td>Ambli, Amla emblica</td>
<td>Fruits</td>
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<td>Solanum incanum L.</td>
<td>Solanaceae</td>
<td>Badi kandyalu</td>
<td>Fruits</td>
<td>jaundice, Sharma et al., 2012</td>
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<td>Tinospora cordifolia (Wild.) Miers</td>
<td>Menispermaceae</td>
<td>Giloe, Gilo</td>
<td>Stems, Roots</td>
<td>jaundice, dysentery, Sharma et al., 2012; Gairola et al., 2013; Mathur and Joshi, 2013</td>
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<td>Tribulus terrestris L.</td>
<td>Zygopogonaceae</td>
<td>Gokrhu</td>
<td>Leaves</td>
<td>jaundice, Sharma et al., 2012</td>
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<td>Medicinal Plants Remedy for Water-borne Diseases in Rural and Remote Areas of Uttarakhand</td>
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<td><strong>Trichosanthes cucumerina L.</strong></td>
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<td>Jangli-chachinda</td>
<td>Fruits</td>
<td>jaundice</td>
<td>Sharma et al., 2012</td>
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<td><strong>Azadirachta indica A. Juss</strong></td>
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<td>Nimba</td>
<td>Bark</td>
<td>jaundice</td>
<td>Sharma et al., 2012</td>
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<td><strong>Balsamoporum solanifolium</strong></td>
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<td>Danti/Vanchura</td>
<td>Roots</td>
<td>jaundice</td>
<td>Sharma et al., 2012; Mathur and Joshi, 2013</td>
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<td>(Burman) Suresh</td>
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<td><strong>Costus speciosus</strong></td>
<td>Zingiberaceae</td>
<td>Kewa</td>
<td>Roots</td>
<td>jaundice</td>
<td>Sharma et al., 2012</td>
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<td>(Koenig) Sm.</td>
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<td><strong>Phyllanthus amarus Schumach. &amp; Thonn.</strong></td>
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<td>Jarmala, Buamla</td>
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<td>Sharma et al., 2012; Gairola et al., 2013</td>
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<td><strong>Solanum americanum Mill.</strong></td>
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<td>Futkaiya</td>
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<td>jaundice</td>
<td>Sharma et al., 2012</td>
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<td><strong>Sphaeranthus senegalensis DC.</strong></td>
<td>Asteraceae</td>
<td>Ghundi, Mundi</td>
<td>Whole Plant, Fruits</td>
<td>jaundice, diarrhoea</td>
<td>Sharma et al., 2012; Gairola et al., 2013</td>
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<td><strong>Acacia catechu</strong></td>
<td>Mimosaceae</td>
<td>Khair, Kattha</td>
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<td>dysentery, diarrhoea</td>
<td>Gairola et al., 2013; Kumar et al., 2011; Kumar et al., 2011; Mathur and Joshi, 2013; Singh and Attri, 2014</td>
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<td>(l.f.) Wild</td>
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<td><strong>Acacia nilotica</strong></td>
<td>Mimosaceae</td>
<td>Babur, Babool</td>
<td>Leaves, Bark</td>
<td>dysentery, diarrhoea</td>
<td>Gairola et al., 2013; Singh and Attri, 2014</td>
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<td>(L.) Dehile</td>
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<td><strong>Achyranthes aspera L.</strong></td>
<td>Amaranthaceae</td>
<td>Ulta chirchita, Amamarga</td>
<td>Whole Plant</td>
<td>dysentery, jaundice</td>
<td>Gairola et al., 2013; Kumari et al., 2011</td>
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<td><strong>Adhatoda zeylanica Medik.</strong></td>
<td>Acanthaceae</td>
<td>Bansa</td>
<td>Leaves</td>
<td>dysentery, diarrhoea</td>
<td>Gairola et al., 2013</td>
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<td><strong>Albizia lebbeck</strong></td>
<td>Mimosaceae</td>
<td>Saris</td>
<td>Bark</td>
<td>diarrhoea</td>
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<td>(L.) Benth.</td>
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<td><strong>Anogeissus latifolia</strong></td>
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<td>Dhaudi</td>
<td>Bark</td>
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<td>Gairola et al., 2013</td>
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<td>(Roxb. Ex DC.) Wall. Ex Bedd.</td>
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<td><strong>Bauhinia variegata L.</strong></td>
<td>Caesalpiniaeae</td>
<td>Kachinal, Kachnar</td>
<td>Flowers, Buds</td>
<td>dysentery, diarrhoea</td>
<td>Gairola et al., 2013; Mathur and Joshi, 2013</td>
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<td><strong>Bombax ceiba L.</strong></td>
<td>Bombacaceae</td>
<td>Sembar</td>
<td>Calyx, Gum</td>
<td>dysentery, diarrhoea</td>
<td>Gairola et al., 2013</td>
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<td><strong>Butea monosperma</strong></td>
<td>Fabaceae</td>
<td>Dhak, Tesu, Palash</td>
<td>Bark, Flowers, Gum, Seeds, Roots</td>
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<td>Gairola et al., 2013; Mathur and Joshi, 2013; Sharma et al., 2017; Gaur and Sharma, 2011</td>
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<td>(Lam.) Taub.</td>
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<td><strong>Celosia argentea L.</strong></td>
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<td>Salara</td>
<td>Seeds, Leaves</td>
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<td><strong>Cocculus hirstus</strong></td>
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<td>(L.) W. Theob.</td>
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<td><strong>Curculigo orthiodes</strong></td>
<td>Hypoxidaceae</td>
<td>Samusli, Kali Musali</td>
<td>Roots, Rhizome, Leaves</td>
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<td>Gairola et al., 2013; Pandey et al., 2017; Singh and Attri, 2014</td>
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<td>Gaertn</td>
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<td><strong>Dalbergia sissoo DC.</strong></td>
<td>Fabaceae</td>
<td>Seesam</td>
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<td><strong>Dioscorea bulbifera L.</strong></td>
<td>Dioscoreaceae</td>
<td>Genti</td>
<td>Roots, Tubers</td>
<td>dysentery, jaundice</td>
<td>Gairola et al., 2013; Gaur and Sharma, 2011</td>
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### Table 2 Continue...

<table>
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<th>Plant Species</th>
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<td>Euphorbia hirta L.</td>
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<td>Lal dudhi</td>
<td>Leaves</td>
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<td>Euphorbia thymifolia L.</td>
<td>Euphorbiaceae</td>
<td>Dudhi</td>
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<td>Ficus benghalensis L.</td>
<td>Moraceae</td>
<td>Bad, Bargad</td>
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<td>Ficus racemosa L.</td>
<td>Moraceae</td>
<td>Gular, Timul</td>
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<td>dysentery, diarrhoea, jaundice</td>
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<td>Helicteres isora L.</td>
<td>Sterculiaceae</td>
<td>Marora, Bhendu, Jonkphal, Avartanacee</td>
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<td>dysentery, diarrhoea</td>
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<td>Hibiscus sabdariffa L.</td>
<td>Malvaceae</td>
<td>Patson</td>
<td>Seeds</td>
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<td>---------------------------------</td>
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</tr>
<tr>
<td>Emblica officinalis Gaertn</td>
<td>Euphorbiaceae</td>
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<tr>
<td>Phyllanthus urinaria L.</td>
<td>Euphorbiaceae</td>
</tr>
<tr>
<td>Quercus leucotrichophora A. Camus</td>
<td>Fagaceae</td>
</tr>
<tr>
<td>Agave americana L.</td>
<td>Agavaceae</td>
</tr>
<tr>
<td>Dioscorea deltoidea Wall. Ex Kunth.</td>
<td>Diosceraceae</td>
</tr>
<tr>
<td>Allium stracheyi Baker</td>
<td>Liliaceae</td>
</tr>
<tr>
<td>Asparagus curillus Buch-Ham.ex Roxb.</td>
<td>Liliaceae</td>
</tr>
<tr>
<td>Lannea coromandelica (Houttyn) Merrill</td>
<td>Anacardiaceae</td>
</tr>
<tr>
<td>Terminalia chebula Retz.</td>
<td>Combretaceae</td>
</tr>
<tr>
<td>Gnaphalium affine D.Don</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Saussurea obvallata (DC.) Edgew.</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Plantago depressa Wild.</td>
<td>Plantaginaceae</td>
</tr>
<tr>
<td>Aconitum heterophyllum Wall. Ex Royle</td>
<td>Ranunculaceae</td>
</tr>
<tr>
<td>Brassica campestris L.</td>
<td>Brassicaceae</td>
</tr>
<tr>
<td>Dactylorhiza hatagirea (D. Don)</td>
<td>Orchidaceae</td>
</tr>
<tr>
<td>Megacarpaea polyandra Benth.</td>
<td>Brassicaceae</td>
</tr>
<tr>
<td>Rheum emodi Wall.</td>
<td>Polygonaceae</td>
</tr>
<tr>
<td>Chenopodium album Linn.</td>
<td>Chenopodiaceae</td>
</tr>
<tr>
<td>Curcuma longa</td>
<td>Zingiberaceae</td>
</tr>
<tr>
<td>Taxus baccata Linn.</td>
<td>Taxaceae</td>
</tr>
<tr>
<td>Baliospermum montanum Will.</td>
<td>Euphorbiaceae</td>
</tr>
<tr>
<td>Celastrus paniculatus Will.</td>
<td>Celastraceae</td>
</tr>
<tr>
<td>Coriandrum sativum</td>
<td>Apiaceae</td>
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<tr>
<td>Rumex hastatus</td>
<td>Polygonaceae</td>
</tr>
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</table>

Table 2 Continue...
### Medicinal Plants Remedy for Water-borne Diseases in Rural and Remote Areas of Uttarakhand

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Family</th>
<th>Part Used</th>
<th>Disease</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Carissa opaca</em> Stapf. Ex. Haines</td>
<td>Apocynaceae</td>
<td>Roots</td>
<td>jaundice, hepatitis</td>
<td>Singh and Attri, 2014</td>
</tr>
<tr>
<td><em>Garguga pinnata</em>, Roxb</td>
<td>Burseraceae</td>
<td>Leaves</td>
<td>diarrhoea</td>
<td>Singh and Attri, 2014</td>
</tr>
<tr>
<td><em>Cassia occidentalis</em> Linn.</td>
<td>Caesalpiniaceae</td>
<td>Leaves, Bark</td>
<td>jaundice</td>
<td>Singh and Attri, 2014</td>
</tr>
<tr>
<td><em>Cicer arietinum</em> Linn.</td>
<td>Fabaceae</td>
<td>Fruits</td>
<td>dysentery</td>
<td>Singh and Attri, 2014</td>
</tr>
<tr>
<td><em>Paris polyphylla</em>, Smith</td>
<td>Liliaceae</td>
<td>Roots</td>
<td>diarrhoea</td>
<td>Singh and Attri, 2014</td>
</tr>
<tr>
<td><em>Toona ciliata</em> Roem</td>
<td>Meliaceae</td>
<td>Bark, Fruits, Leaves</td>
<td>dysentery</td>
<td>Singh and Attri, 2014</td>
</tr>
<tr>
<td><em>Premna barbata</em> Wall.</td>
<td>Verbenaceae</td>
<td>Bark, Leaves</td>
<td>diarrhoea</td>
<td>Singh and Attri, 2014</td>
</tr>
<tr>
<td><em>Viola canescens</em> Wall. Ex. Roxb</td>
<td>Violaceae</td>
<td>Flowers, Leaves</td>
<td>jaundice</td>
<td>Singh and Attri, 2014</td>
</tr>
<tr>
<td><em>Citrus aurantiifolia</em> (Christm) Swingle</td>
<td>Rutaceae</td>
<td>Flowers, Leaves</td>
<td>jaundice, diarrhoea</td>
<td>Singh <em>et al.</em>, 2017</td>
</tr>
<tr>
<td><em>Solanum khasianum</em> C.B. Clarke</td>
<td>Solanaceae</td>
<td>Fruits, Roots</td>
<td>jaundice</td>
<td>Singh <em>et al.</em>, 2017</td>
</tr>
<tr>
<td><em>Flemingia vestita</em> Benth</td>
<td>Fabaceae</td>
<td>Roots</td>
<td>dysentery</td>
<td>Gaur and Sharma, 2011</td>
</tr>
<tr>
<td><em>Meliotus indica</em> (L.)</td>
<td>Fabaceae</td>
<td>Leaves</td>
<td>dysentery</td>
<td>Gaur and Sharma, 2011</td>
</tr>
<tr>
<td><em>Litsea glutinosa</em> (Lour). Robin</td>
<td>Lauraceae</td>
<td>Bark, Fruits</td>
<td>dysentery, diarrhoea</td>
<td>Gaur and Sharma, 2011</td>
</tr>
<tr>
<td><em>Ficus auriculata</em> Lour</td>
<td>Moraceae</td>
<td>Fruits</td>
<td>dysentery</td>
<td>Gaur and Sharma, 2011</td>
</tr>
<tr>
<td><em>Coe lacryma-jobi</em> L.</td>
<td>Poaceae</td>
<td>Fruits</td>
<td>dysentery, diarrhoea</td>
<td>Gaur and Sharma, 2011</td>
</tr>
<tr>
<td><em>Persicaria capitata</em> (Buch-Ham) H.Gross</td>
<td>Polygonaceae</td>
<td>Kafla, Dhadhura</td>
<td>Roots</td>
<td>dysentery</td>
</tr>
<tr>
<td><em>Engelhardtia spicata</em> Lesch. Ex Blume</td>
<td>Juglandaceae</td>
<td>Mowa</td>
<td>Bark</td>
<td>diarrhoea</td>
</tr>
<tr>
<td><em>Pavetta tomentosa</em> Roxb. Ex J.E. Smith</td>
<td>Rubiaceae</td>
<td>Damaya, Leaves, Roots</td>
<td>jaundice</td>
<td>Malik <em>et al.</em>, 2015</td>
</tr>
<tr>
<td><em>Spermatocytion sanveolens</em> Roxb</td>
<td>Rubiaceae</td>
<td>Roots</td>
<td>diarrhoea, cholera</td>
<td>Malik <em>et al.</em>, 2015</td>
</tr>
<tr>
<td><em>Rumex nepalensis</em> Sprengel</td>
<td>Polygonaceae</td>
<td>Pahadipalak</td>
<td>Roots, Leaves</td>
<td>dysentery</td>
</tr>
<tr>
<td><em>Rosa brunonii</em> Lindley</td>
<td>Rosaceae</td>
<td>Leaves, Flowers</td>
<td>diarrhoea</td>
<td>Malik <em>et al.</em>, 2015</td>
</tr>
</tbody>
</table>
and remote zones, thus, local people and tribal’s are well versed with available medicinal plants and therapeutic usage. On surveying, three tribal communities i.e. Bhoxa, Gujjars and Tharu living in the sub-Himalayan region discovered 40 species of plant that have therapeutic potential for treating Jaundice (Sharma et al., 2012). Bhoxa community of district Dehradun used 50 plant species as a remedy for both dysentery and diarrhoea (Gairola et al., 2013). Kedarnath village people introduced us to 49 species of medicinal plants that commonly used for treating various illnesses (Bhat et al., 2013). On the other hand, villagers of district Bagseshwar categorized the plant species according different ailments like 14 species for jaundice, 12 species for diarrhoea and 16 species for dysentery (Pandey et al., 2017). From Udham Singh Nagar district, Tharu tribe provided the information of 53 species of plant for treating the different diseases including jaundice and diarrhoea (Sharma et al., 2011). Rudraprayag people reported about the usage of 40 ethnomedicinal plants for curing diarrhoea and dysentery (Chandra et al., 2013). Survey conducted on questioning local people of the state confirmed that most of relies on these herbs and plant for treating jaundice (Phondani, 2011). But, nowadays, this knowledge is limited to traditional healers and elder people (Bujurg) as young generation are not interested in learning about ethnomedicinal plants and their usage (Singh et al., 2017). Moreover, Out-migration of population from hilly region is additional factor contributing for reduce knowledge about the medicinal plants in people living in these hilly areas (NIRD, 2015).

Conservation and management of medicinal plants

When Uttarakhand was declared as the Herbal State, government bodies took the initiative to cultivate these medicinal plants in regulated manner for their conservation. Agriculture and Food Processing Authority was appointed as nodal agency which aim to promote for developing two phases of Agri Export Zones: First phase will be covering six districts Chamoli, Dehradun, Haridwar, Pithoragarh, Udham Singh Nagar and Uttarkashi which will cultivate 10 medical plant species (high value) on 500 ha land and in their next phase, they will increase the cultivation land by adding other districts in the aegis of Agri Export Zones. This has become the reality with the support of Infrastructure Development Finance Company which is promoting India in the world market. In Gopeshwar, Chamoli district the state has started Herbal Research and Development Institute which will monitor development issues of medicinal plants in the state (Topwal and Uniyal, 2018). Ethnic community of Uttarakhal, both economically and logistically rely on the native plant species for their usage in traditional healthcare system.

Hence, collaboration of government institutes, nongovernment organizations (NGOs) and research scientist is recommended to preserve the traditional knowledge and medicinal plants to sustain the livelihood of rural economy in coming future (Dhar et al., 2002). In order to conserve the medicinal plants (high-value) we need the sincere and serious support of the stakeholders. Whereas, preventive measure needs to be taken for ex situ conservation to comprehend the total activities in given time requires concentration and identification. Here, interest of farmers in conservation strategy plays the vital role in representative cultivation trials. With the perception of diversity conservation, cultivation and domestication via improve invention, these aromatic and medicinal plants serve as the valuable resource for sustainable livelihood and natural resource management (Maikhuri et al., 2005, Negi et al., 2010). Moreover, cultivation on abandoned, barren and marginal land improves the livelihood of farmers and aid in preserving diversity of these medicinal plant in their native environment, will be first step towards the mutual benefits (Phondani et al., 2001). Both ex-situ (off site) and in-situ (on site) conservation complement each other and equally important. But it has been observed that in-situ conservation of genetic information of crop is still remains outrageous. In reality, in situ conservation approach is dynamic over ex-situ conservation, as it acts as repository of crop genetic resources, on the other hand, plant continuously evolve under natural condition during ex-situ conservation. Hence, various secure areas like biosphere reserves, wildlife sanctuaries and national parks are in existence and being proposed in Himalayan region.

Ex situ conservation

Numerous institutions involving agricultural research centers, botanical gardens and forestry research institutes are helping in maintaining the ex-situ populations of medicinal plants. Following are the methods involved:

1. **Botanical gardens:** They have collection of plants similar to field gene banks and they also contain few endangered species of plant.

2. **Field gene banks:** They involve a particular area where genetically diverse plants are assembled together. Here, material of plant is preserved which remains available for breeding and other research purpose. By this we are able to preserve the shrubs and long living perennials trees.

3. **Seed banks:** This approach is effective for ex-situ conservation as we can store reproducing seeds for
long period. This being the compact storage method but it requires continuous surveillance, viability testing and regeneration ability as to maintain viability value above particular level. On of the biggest of repository of plant a genetic resource in India is NBPGR (National Bureau of Plant Genetic Resources). Additionally, there are various seed banks worldwide, which are differentiated on the basis on nature of collection, location, taxonomic group of forestry trees and wild plants, etc.

4. **In vitro storage**: This process involves germplasm conservation obtained from tissue meristem in test tubes. These procedures are followed when we need to store plant species propagules for long term, which cannot be maintained via seed banks. This method has its own limitation in applicability.

It has been noted that various herbal gardens/parks have been established in the past. But need to maintain those sites and use them to create new setups as well as linked to educational and awareness activities.

**Conclusion**

Medicinal plants are the rich resources for health care among the people of India. Uttarakhand is a storehouse of a rich variety herbs and medicinal and aromatic plant species. However, local residents of this region particularly, women and tribal people are well versed with the knowledge of traditional medicinal plants whereas, young generation lacks this knowledge. Even with large variety of medicinal plants, Uttarakhand people suffer from the water-borne diseases. This state holds the great potential for cultivating these medicinal plants to sustain these pharmaceutical important plants. Therefore, regular surveillance, development of improved protocols, latest conservation strategies and replication of these approaches in other parts of Himalayan region is highly recommended.

**References**


Kumari, P., G.C. Joshi and L.M. Tewari (2011). Diversity and
Kanchan Bhardwaj


