Plant Archives Vol. 19 No. 2, 2019 pp. 4505-4520 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

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 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 fortune 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

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Table 1: Water-borne diseases cases in Uttarakhand from 2011- 2018.

Year	No. of acute diar-rhoea cases	No. of deaths	No. of viral hepa-titis E cases	No. of deaths	No. of jaun-dice cases	No. of deaths	No. of viral hepa-titis A cases	No. of deaths	No. of viral hepa-titis A & E cases	No. of deaths	No. of typ-hoid cases	No. of deaths	No. of susp-ected hepa-titis cases	No. of deaths	No. of cho-lera cases	No. of deaths
2011	164	0	0	0	0	0	0	0	0	0	0	0	141	0	27	0
2012	236	1	58	0	0	0	18	0	16	1	0	0	30	0	0	0
2013	215	4	22	0	0	0	15	0	51	0	0	0	11	0	0	0
2014	105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	84	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0
2016	207	0	20	0	55	0	13	0	8	0	0	0	0	0	0	0
2017	20	0	38	0	0	0	0	0	0	0	35	0	0	0	0	0
2018	68	0	0	0	0	0	5	0	0	0	15	0	40	0	0	0

Compiled from source: http://www.idsp.nic.in

open-filed defection practices was chief contributor for such illness (Vyas *et al*., 2014).

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.

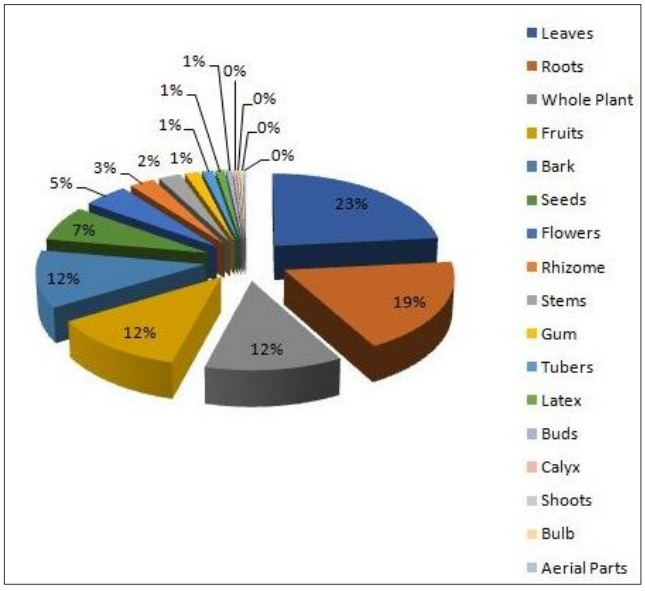

Fig. 1: Percentage of the various plant parts used as a medication.

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.

Name of the plant species	Family	Local names	Plant parts used	Ailments treated	References
Aloe vera (L.) Burn f.	Lilliaceae	Banskyuda	Leaves	jaundice, dysentery	Sharma *et al.,* 2012; Gairola *et al.,* 2013; Mehra *et al.,* 2014
Argemone mexicana L.	Papaveraceae	Pili Katili, Pauns, Satyanasi	Latex, Whole Plant	jaundice	Sharma *et al.,* 2012; Mathur and Joshi, 2013
Boerhavia diffusa L.	Nyctaginaceae	Santi ghass /Puraniama, Peelia, Punarnava, Punryaru	Roots, Whole Plant	jaundice, dysentery, diarrhoea	Sharma *et al.,* 2012; Gairola *et al.,* 2013; Mathur and Joshi, 2013; Kumari *et al.,* 2011; Mehra *et al.,* 2014; Pandey *et al.,* 2017
Centella asiatica (L.) Urb.	Apiaceae	Bimi, Brahmi	Leaves, Whole Plant	jaundice, dysentery, diarrhoea, cholera	Sharma *et al.,* 2012; Pandey *et al.,* 2017; Singh and Attri, 2014
Eclipta prostrata (L.) L.	Asteraceae	Bhangra, Mokchand	Leaves, Whole Plant	jaundice	Sharma *et al.,* 2012; Mathur and Joshi, 2013
Flacourita indica (Burn. F.) Merr.	Flacourtiaceae	Kaki/ Bhilangra, Kaith	Leaves, Fruits	jaundice	Sharma *et al.,* 2012
Glycosmis pentaphylla (Retz.) DC	Rutaceae	Pillu	Leaves	jaundice	Sharma *et al.,* 2012
Haldina cordifolia (Roxb.) Ridsdale	Rubiaceae	Haldu	Bark	jaundice	Sharma *et al.,* 2012
Holarrhena pubescens Wall.	Apocynaceae	Kuda	Seeds, Bark	jaundice, dysentery	Sharma *et al.,* 2012; Gairola *et al.,* 2013
Lawsonia inermis L.	Lythraceae	Mehndi	Roots	jaundice	Sharma *et al.,* 2012
Momordica charantia L.	Cucurbitaceae	Karela	Fruits	jaundice	Sharma *et al.,* 2012; Singh and Attri, 2014
Oroxylum indicum (L.) Kurz	Bignoniaceae	Arula, Pharkat, Tantiya	Bark, Seeds, Roots, Stems	jaundice, dysentery, diarrhoea	Sharma *et al.,* 2012; Gairola *et al.,* 2013; Singh and Attri, 2014; Gaur and Sharma, 2011
Physalis divaricata D. Don	Solanaceae	Bhambholan	Roots	jaundice	Sharma *et al.,* 2012
Vitex negundo L.	Verbenaceae	Sambhalu	Leaves, Whole Plant, Flowers	jaundice, dysentery, diarrhoea	Sharma *et al.,* 2012; Gairola *et al.,* 2013
Woodfordia fruticosa (L.) Kurz	Lythraceae	Dhaudi, Dhau	Fruits, Flowers, Leaves, Buds	jaundice, dysentery, cholera	Sharma *et al.,* 2012; Gairola *et al.,* 2013; Singh and Attri, 2014; Gaur and Sharma, 2011
Amaranthus spinosus L.	Amaranthaceae	Chaleri	Fruits	jaundice	Sharma *et al.,* 2012
Andrographis paniculata (Burn. F.) Nees	Acanthaceae	Mamegh, Kalmedh, Kiryat	Leaves, Whole Plant	jaundice, dysentery	Sharma *et al.,* 2012; Mathur and Joshi, 2013

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Averrhoa carambola L.	Averrhoaceae	Kamrakt	Fruits	jaundice	Sharma *et al.,* 2012
Benincasa hispida (Thunb) Cogn.	Cucurbitaceae	Kumara	Fruits	jaundice	Sharma *et al.,* 2012
Cajanus cajan (L.) Millsp	Fabaceae	Rahar, Arhar	Leaves	jaundice, cholera	Sharma *et al.,* 2012; Prakash, 2015; Sharma *et al.,* 2011
Cassia fistula L.	Caesalpiniaceae	Karangal, Amaltas, Simaru	Fruits, Leaves	jaundice, dysentery, diarrhoea	Sharma *et al.,* 2012; Gairola *et al.,* 2013; Dangwal and Sharma, 2011
Cissampelos pareira L.	Menispermaceae	Paadha /Simrubel, Jaljamini, Pari	Leaves, Whole Plant, Roots	jaundice, dysentery, diarrhoea	Sharma *et al.,* 2012; Gairola *et al.,* 2013; Kumari *et al.,* 2011; Pandey *et al.,* 2017
Cuscuta reflexa Roxb.	Cuscutaceae	Andarbel, Sarai-Babiya	Whole Plant, Seeds	jaundice	Sharma *et al.,* 2012
Cynodon dactylon (L.) Pers.	Poaceae	Dhoob, Dubghass, Dubar	Leaves, Whole Plant, Stems	jaundice, dysentery, diarrhoea	Sharma *et al.,* 2012; Gairola *et al.,* 2013; Pandey *et al.,* 2017; Semwal *et al.,* 2010; Mathur and Joshi, 2012; Singh and Attri, 2014
Ehretia laevis Roxb.	Ehretiaceae	Chamror /Chamrod	Seeds	jaundice	Sharma *et al.,* 2012
Ficus religiosa L.	Moraceae	Badh, Pipal	Bark, Leaves, Fruits	jaundice, diarrhoea	Sharma *et al.,* 2012; Singh and Attri, 2014
Mangifera indica L.	Anacardiaceae	Amm	Bark, Leaves, Stems, Seeds	jaundice, dysentery, diarrhoea	Sharma *et al.,* 2012, Singh and Attri, 2014; Singh *et al.* ,2017
Ocimum americanum L.	Lamiaceae	Tulsa	Whole Plant	jaundice	Sharma *et al.,* 2012
Oxalis corniculata L.	Oxalidaceae	Khati amli, Amlolo, Amrul, Anboti, Chalmori, Chilmora, Tinpatiya	Leaves, Whole Plant	jaundice, dysentery, diarrhoea	Sharma *et al.,* 2012; Mathur and Joshi, 2013; Kumari *et al.,* 2011; Singh and Attri, 2014
Phyllanthus emblica	Euphorbiaceae	Ambli, Amla *emblica*	Fruits	jaundice, diarrhoea	Sharma *et al.,* 2012; Mathur and Joshi, 2013; Sharma *et al.,* 2011
Solanum incanum L.	Solanaceae	Badi kandyalu	Fruits	jaundice	Sharma *et al.,* 2012
Tinospora cordifolia (Wild.) Miers	Menisp-ermaceae	Giloe, Gilo	Stems, Roots	jaundice, dysentery	Sharma *et al.,* 2012; Gairola *et al.,* 2013; Mathur and Joshi, 2013
Tribulus terrestris L.	Zygop-hyllaceae	Gokrhu	Leaves	jaundice	Sharma *et al.,* 2012

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Trichosanthes cucumerina L.	Cucurbitaceae	Jangli-chachinda	Fruits	jaundice	Sharma *et al.,* 2012
Azadirachta indica A. Juss	Meliaceae	Nimba	Bark	jaundice	Sharma *et al.,* 2012
Baliospermum solanifolium (Burm.) Suresh	Euphor-biaceae	Danti /Vanchura	Roots	jaundice	Sharma *et al.,* 2012; Mathur and Joshi, 2013
Costus speciosus (Koenig) Sm.	Zingibe-raceae	Kewa	Roots	jaundice	Sharma *et al.,* 2012
Phyllanthus amarus Schumach. & Thonn.	Euphor-biaceae	Jarmala, Buiamla	Whole Plant	jaundice, dysentery, diarrhoea	Sharma *et al.,* 2012; Gairola *et al.,* 2013
Solanum americanum Mill.	Solanaceae	Futkaiya	Whole Plant	jaundice	Sharma *et al.,* 2012
Sphaeranthus senegalensis DC.	Asteraceae	Ghundi, Mundi	Whole Plant, Fruits	jaundice, diarrhoea	Sharma *et al.,* 2012; Gairola *et al.,* 2013
Acacia catechu (l.f.) Wild	Mimosaceae	Khair, Kattha	Leaves, Bark, Stems	dysentery, diarrhoea	Gairola *et al.,* 2013; Kumar *et al.,* 2011; Kumar *et al.,* 2011; Mathur and Joshi, 2013; Singh and Attri, 2014
Acacia nilotica (L.) Delile	Mimosaceae	Babur, Babool	Leaves, Bark	dysentery, diarrhoea	Gairola *et al.,* 2013; Singh and Attri, 2014
Achyranthes aspera L.	Amaran-thaceae	Ulta chirchita, Apamarga	Whole Plant	dysentery, jaundice	Gairola *et al.,* 2013; Kumari *et al.,* 2011
Adhatoda zeylanica Medik.	Acanthaceae	Bansa	Leaves	dysentery, diarrhoea	Gairola *et al.,* 2013
Albizia lebbeck (L.) Benth.	Mimosaceae	Saris	Bark	diarrhoea	Gairola *et al.,* 2013
Anogeissus latifolia (Roxb. Ex DC.) Wall. Ex Bedd.	Combretaceae	Dhaudi	Bark	dysentery, diarrhoea	Gairola *et al.,* 2013
Bauhinia variegata L.	Caesal-piniaceae	Kachnal, Kachnar	Flowers, Buds	dysentery, diarrhoea	Gairola *et al.,* 2013; Mathur and Joshi, 2013
Bombax ceiba L.	Bombacaceae	Sembar	Calyx, Gum	dysentery, diarrhoea	Gairola *et al.,* 2013
Butea monosperma (Lam.) Taub.	Fabaceae	Dhak, Tesu, Palash	Bark, Flowers, Gum, Seeds, Roots	dysentery, diarrhoea	Gairola *et al.,* 2013; Mathur and Joshi, 2013; Sharma *et al.,* 2017; Gaur and Sharma, 2011
Celosia argentea L.	Amaranthaceae	Salera	Seeds, Leaves	dysentery, diarrhoea	Gairola *et al.,* 2013
Cocculus hirstus (L.) W. Theob.	Menispe-rmaceae	Jaljamuni	Leaves	dysentery, diarrhoea	Gairola *et al.,* 2013
Curculigo orchiodes Gaertn	Hypoxidaceae	Samusli, Kali Musali	Roots, Rhizome, Leaves	dysentery, diarrhoea, jaundice	Gairola *et al.,* 2013; Pandey *et al.,* 2017; Singh and Attri, 2014
Dalbergia sissoo DC.	Fabaceae	Seesam	Leaves	dysentery, diarrhoea	Gairola *et al.,* 2013; Mathur and Joshi, 2013
Dioscorea bulbifera L.	Dioscereaceae	Genti	Roots, Tubers	dysentery, jaundice	Gairola *et al.,* 2013; Gaur and Sharma, 2011

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Euphorbia hirta L.	Euphorbiaceae	Lal dudhi	Leaves	dysentery	Gairola *et al.,* 2013
Euphorbia thymifolia L.	Euphor-biaceae	Dudhi	Whole Plant	dysentery, diarrhoea, cholera	Gairola *et al.,* 2013; Pandey *et al.,* 2017
Ficus benghalensis L.	Moraceae	Bad, Bargad	Roots, Bark	dysentery, diarrhoea	Gairola *et al.,* 2013; Chandra *et al.,* 2013
Ficus racemosa L.	Moraceae	Gular, Timul	Latex, Whole Plant, Bark	dysentery, diarrhoea, jaundice	Gairola *et al.,* 2013; Mathur and Joshi, 2013; Singh and Attri, 2014
Helicteres isora L.	Stercu-liaceae	Marora, Bhendu, Jonkphal, Avartanee	Fruits, Bark, Roots	dysentery, diarrhoea	Gairola *et al.,* 2013; Mathur and Joshi, 2013; Kumar and Pandey, 2015; Gaur and Sharma, 2011
Hibiscus sabdariffa L.	Malvaceae	Patson	Seeds	dysentery	Gairola *et al.,* 2013
Madhuca longifolia (J. Konig ex L.) J.F. Macbr.	Sapotaceae	Mahua	Flowers	diarrhoea	Gairola *et al.,* 2013
Mimosa pudica	Mimosaceae	Sharmili, Chui-mui	Whole Plant	dysentery	Gairola *et al.,* 2013; Gaur and Sharma, 2011
Murraya koenigii (L.) Spreng	Rutaceae	Pinvaran, Mitha Neem, Kadhi Patta, Gandel	Leaves	dysentery, diarrhoea	Gairola *et al.,* 2013; Mathur and Joshi, 2013; Gaur and Sharma, 2011
Musa balbisiana Colla	Musceae	Kela	Roots, Bark, Fruits	dysentery, diarrhoea	Gairola *et al.,* 2013; Singh *et al.,* 2017
Ocimum tenuiflorum L.	Lamiaceae	Tulsi	Whole plant	diarrhoea	Gairola *et al.,* 2013
Ougeinia oojeinesis (Roxb.) Hochr.	Fabaceae	Sandan	Gum	dysentery	Gairola *et al.,* 2013
Prunus persica (L.) Stokes	Rosaceae	Aaru	Leaves	dysentery	Gairola *et al.,* 2013
Sesbania sesban (L.) Merr.	Fabaceae	Jayantee	Seeds	dysentery	Gairola *et al.,* 2013
Shorea robusta Gaertn	Diptero-carpaceae	Sakhu, Sal	Gum, Bark	dysentery, diarrhoea	Gairola *et al.,* 2013; Kumari *et al.,* 2011; Dangwal and Sharma, 2011; Singh and Attri, 2014
Spondias pinnata (L.f.) Kurz	Anacardiaceae	Aamra	Fruits	dysentery, diarrhoea	Gairola *et al.,* 2013
Sterculia villosa Roxb.	Sterculiaceae	Udal	Gum	dysentery	Gairola *et al.,* 2013
Syzygium cumini (L.) Skeels	Myrtaceae	Jamun	Bark, Leaves, Roots	dysentery, diarrhoea	Gairola *et al.,* 2013; Mathur and Joshi, 2013; Pandey *et al.,* 2017; Singh *et al.,* 2017
Terminalia arjuna (Roxb. Ex DC.) Wight & Arn.	Combretaceae	Arjun	Bark	dysentery	Gairola *et al.,* 2013; Mathur and Joshi, 2013

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Terminalia bellirica (Gaertn.) Roxb.	Combretaceae	Bahera	Fruits	diarrhoea	Gairola *et al.,* 2013
Tridax procumbens (L.) L.	Asteraceae	Phulli, Gujrati	Leaves	dysentery	Gairola *et al.,* 2013; Mathur and Joshi, 2013
Vernonia cinerea (L.) Less.	Asteraceae	Sehdevi	Whole Plant, Leaves, Seeds, Roots	dysentery	Gairola *et al.,* 2013; Bhat *et al.,* 2013; Mathur and Joshi, 2013
Ziziphus mauritiana Lam.	Rhamnaceae	Ber	Bark, Seeds, Fruits	diarrhoea	Gairola *et al.,* 2013; Mathur and Joshi, 2013; Pandey *et al.,* 2017
Ziziphus mummularia (Burm. F.) Wight & Arn.	Rhamnaceae	Jharber	Roots	dysentery, diarrhoea	Gairola *et al.,* 2013
Cotoneaster duthieana (Schneid.) Klotz	Rosaceae	Rensu	Fruits	diarrhoea	Rawat *et al.,* 2013
Viola pilosa Blume	Violaceae	Vansfa	Flowers	jaundice	Rawat *et al.,* 2013
Bistorta affinis (D. Don) Greene	Polygonaceae	Inuri	Shoots	dysentery	Rawat *et al.,* 2013
Gentiana tubiflora (G. Don) Griseb	Gentianaceae	Chiratu	Whole Plant	jaundice	Rawat *et al.,* 2013
Pedicularis longiflora Rudolph	Scrophu-lariaceae	Kunkurjhar	Whole Plant	dysentery	Rawat *et al.,* 2013
Berberies asiatica Roxb. subsp. *Tubiformis* (Klotz.) Pennell	Barberidaceae	Kilmori	Roots	dysentery, diarrhoea, jaundice	Kapkoti *et al.,* 2014; Mehra *et al.,* 2014; Pandey *et al.,* 2017
Hypericum oblongifolium Choisy	Hypericaceae	Piyoli	Flowers	jaundice	Kapkoti *et al.,* 2014
Rubus ellipticus Smith	Rosaceae	Hishalu	Whole Plant, Fruits	diarrhoea, cholera	Kapkoti *et al.,* 2014; Kumari *et al.,* 2011; Mehra *et al.,* 2014; Pandey *et al.,* 2017
Angiopteris evecta Hoffm.	Angiopte-ridaceae	NS	Rhizome	diarrhoea	Upreti *et al.,* 2009
Asplenium nidus L.	Aspleniaceae	NS	ND	jaundice	Upreti *et al.,* 2009
Botrychium ternatum (Thunb.) Sw.	Botrychiaceae	NS	Roots	dysentery	Upreti *et al.,* 2009
Pteris wallichiana	Pteridaceae	Agardh	ND	dysentery	Upreti *et al.,* 2009
Holarrhena antidysenterica (L.) Wall. Ex A. DC.	Apocynaceae	Kura	Bark, Seeds, Leaves	dysentery	Kumar *et al.,* 2011
Rhus parviflora Roxb.	Anacardiaceae	Tungla, Toong	Leaves, Whole Plant	cholera	Kumar *et al.,* 2011; Kumar *et al.,* 2011; Pandey *et al.,* 2017; Singh and Attri, 2014; Malik *et al.,* 2015

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Indigofera gerardiana Wall. Ex Baker	Fabaceae	Sakina	Leaves	dysentery, diarrhoea	Kumar *et al.,* 2011; Kumar *et al.,* 2011
Prinsipia utillis Royle	Rosaceae	Bhainkal	Seeds, Bark	diarrhoea	Kumar *et al.,* 2011; Bhat *et al.,* 2013; Kumar *et al.,* 2011
Launaea asplenifolia Hook f.	Asteraceae	Dudhliya	Roots	diarrhoea	Kumar *et al.,* 2011
Commelina benghalensis L.	Commeli-naceae	Kanjula, Simalu	Whole Plant, Leaves	dysentery, jaundice	Kumar *et al.,* 2011; Kumar and Pandey, 2015
Aegle marmelos (L.) Corea	Rutaceae	Bel, Belpatri	Fruits, Leaves, Roots	cholera, diarrhoea, dysentery, jaundice	Prakash, 2015; Mathur and Joshi, 2013; Kumari *et al.,* 2011; Sharma *et al.,* 2011; Sharma *et al.,* 2017; Singh and Attri, 2014; Gaur and Sharma, 2011
Allium sativum L.	Lilliaceae	Lehsun	Bulb	diarrhoea	Prakash, 2015; Sharma *et al.,* 2011
Alstonia scholaris (L.) R.Br	Apocynaceae	Chitwan	Bark	cholera	Prakash, 2015
Cannabis sativa L.	Cannabinaceae	Bhang	Leaves	dysentery	Prakash, 2015, Sharma *et al.,* 2011
Coccinia grandis (L.) Voigt	Cucurbitaceae	Kanduri	Leaves	cholera	Prakash, 2015
Berberis chitria Lindl.	Berberidaceae	Kingor /Chotar	Fruits, Bark, Roots	jaundice	Prakash, 2015
Anemone obtusiloba D. Don	Ranunculaceae	Kanchphool	Roots	diarrhoea	Bhat *et al.,* 2013; Phondani, 2011
Asparagus filicinus Buch-Ham. Ex D.Don	Aspargaceae	NS	Tubers	dysentery, diarrhoea	Bhat *et al.,* 2013
Bergenia ciliata (Haw.) Sternb.	Taxaceae	Pathar-Chatta, Pashanbhaed	Roots, Rhizome	diarrhoea	Bhat *et al.,* 2013; Singh and Attri, 2014; Malik *et al.,* 2015
Bistorta amplexicaulis (D.Don) Greene	Polygonaceae	NS	Leaves	dysentery	Bhat *et al.,* 2013
Euphorbia hypericifolia L.	Euphorbiaceae	NS	Leaves	dysentery, diarrhoea	Bhat *et al.,* 2013
Geranium wallichianum D.Don ex Sweet	Geraniaceae	Kaphla, Ratan-Jhoot	Roots	dysentery, cholera	Bhat *et al.,* 2013; Singh and Attri, 2014; Malik *et al.,* 2015
Indigofera heterantha Wall.ex Bandis	Fabaceae	NS	Leaves	dysentery, diarrhoea	Bhat *et al.,* 2013
Myrica esculenta Buch-Ham ex D.Don	Myriccaceae	NS	Fruits	diarrhoea	Bhat *et al.,* 2013
Origanum vulgare L.	Lamiaceae	Ban Tulsi	Whole Plant, Leaves	diarrhoea	Bhat *et al.,* 2013; Kumar *et al.,* 2011; Rana *et al.,* 2013

Table 2 Continue...

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Paeonia emodii Wall. Ex Royle	Paeoniaceae	Chandrayan, Chandra, Dhandrah	Roots, Flowers, Leaves	dysentery, diarrhoea	Bhat *et al.,* 2013; Pandey *et al.,* 2017; Semwal *et al.,* 2010; Malik *et al.,* 2015
Pimpinella acuminata (Edge.) C.B. Clarke	Apiaceae	NS	Whole Plant	dysentery, diarrhoea	Bhat *et al.,* 2013
Plantago himalacia Pilger	Plantaginaceae	Isopgol	Leaves, Seeds	dysentery, diarrhoea	Bhat *et al.,* 2013; Singh and Attri, 2014
Rhododendron arboreum Smith	Ericaceae	Burans	Flowers, Bark, Leaves	dysentery, diarrhoea, jaundice	Bhat *et al.,* 2013; Kumari *et al.,* 2011; Pandey *et al.,* 2017; Singh and Attri, 2014
Rhus javanica L.	Anacardiaceae	Damfel	Fruits, Bark	cholera	Bhat *et al.,* 2013; Malik *et al.,* 2015
Rubia manjith Roxb. Ex Fleming	Rubiaceae	Manjeet	Flowers, Roots	dysentery, jaundice	Bhat *et al.,* 2013; Dangwal and Sharma, 2011
Ageratum conyzoides (L.) L.	Asteraceae	Gundrya	Aerial Parts	dysentery, diarrhoea	Chandra *et al.,* 2013
Mucuna pruriens (L.) DC.	Fabaceae	Kaunch	Leaves	diarrhoea	Chandra *et al.,* 2013
Abutilon indicum (L.) Sweet	Malvaceae	Kanghe	Leaves	diarrhoea	Chandra *et al.,* 2013
Ficus subincisa Buch-Ham ex Sm.	Moraceae	Umaru	Roots, Latex	diarrhoea	Chandra *et al.,* 2013
Datura inoxia Mill.	Solanaceae	Dhatura	Leaves	diarrhoea	Chandra *et al.,* 2013
Barleria prionitis L.	Acanthaceae	Piya Basa	Leaves	diarrhoea	Mathur and Joshi, 2013
Acorus calamus L.	Acoraceae	Gorbach, Vacha, Bauj	Rhizome	dysentery, diarrhoea	Mathur and Joshi, 2013; Gaur and Sharma, 2011
Aerva sanguinolenta (L.) Blume	Amaranthaceae	Gorakh Boonti	Roots	dysentery	Mathur and Joshi, 2013
Amaranthus polygamus L.	Amaranthaceae	Bari Chaulai, Lal Sag	Whole Plant	dysentery, diarrhoea	Mathur and Joshi, 2013
Annona squamosa L.	Annonaceae	Sharifa	Bark	dysentery, diarrhoea	Mathur and Joshi, 2013
Asclepias curassavica L.	Apocynaceae	Chatian, Saptaparna, Shaitan	Leaves, Roots, Flowers	dysentery	Mathur and Joshi, 2013
Asparagus adscendens Roxb.	Aspargaceae	Safed Musli, Shatavar	Roots	dysentery, diarrhoea	Mathur and Joshi, 2013; Pandey *et al.,* 2017
Parthenium hysterophorus L.	Asteraceae	Gajar Ghans	Roots	dysentery	Mathur and Joshi, 2013
Spilanthes paniculata Wall. Ex Dc.	Asteraceae	Para Ghans	Whole Plant	dysentery	Mathur and Joshi, 2013
Thuja occidentalis L.	Cupressaceae	Morpankhi, Mayurpankh	Roots, Stems	dysentery, diarrhoea	Mathur and Joshi, 2013
Albizia amara (Roxb.) B.Boiv	Fabaceae	Lallei	Seeds	diarrhoea	Mathur and Joshi, 2013
Desmodium gangeticum (L) DC.	Fabaceae	Sarivan, Salparni	Roots	diarrhoea, dysentery	Mathur and Joshi, 2013

Table 2 Continue...

Continue Table 2 ...

Punica granatum L.	Lythraceae	Anar	Fruits	diarrhoea	Mathur and Joshi, 2013
Malvastrum coromandelianum (L.) Garcke	Malvaceae	Kangi, Bariar	Whole Plant	dysentery	Mathur and Joshi, 2013
Morus alba L.	Moraceae	Shahoot	Fruits	hepatitis	Mathur and Joshi, 2013
Psidium guajava L.	Myrtaceae	Amrud, Jamphal, Bihi	Leaves, Bark	cholera, diarrhoea, dysentery	Mathur and Joshi, 2013; Sharma *et al.,* 2011; Singh *et al.,* 2017
Phyllanthus fraternus G.L. Webster	Phyllanthaceae	Jarmala, Bhuinanvalah, Bhoomi Anonla	Whole Plant, Roots	dysentery, diarrhoea, jaundice	Mathur and Joshi, 2013; Kumari *et al.,* 2011
Plantago ovata Forsk.	Plantaginaceae	Isaphgol	Seeds	dysentery	Mathur and Joshi, 2013
Fragaria vesca L.	Rosaceae	Banaphal	Leaves	diarrhoea	Mathur and Joshi, 2013
Ixora coccinea L.	Rubiaceae	Rangan, Rokmani	Roots	dysentery, diarrhoea	Mathur and Joshi, 2013
Murraya paniculata (L.) Jack.	Rutaceae	Kamini	Leaves	dysentery, diarrhoea	Mathur and Joshi, 2013; Sharma *et al.,* 2017
Taraxacum officinale	Asteraceae	Dudya Ghas	Roots, Leaves	jaundice	Dangwal *et al.,* 2010; Dangwal *et al.,* 2011
Boenninghausenia albiflora Hook. Reichb. Ex Meisn	Rutaceae	Upniya Ghas	Leaves, Roots	dysentery	Phondani, 2011
Borreria articularis L.f.F.N Williams	Rubiaceae	Guthari	Seeds	diarrhoea	Phondani, 2011
Leucas cephalotes (Roth) Spreng.	Lamiaceae	Guma	Whole Plant, Leaves	jaundice, diarrhoea	Kumari *et al.,* 2011
Abrus precatorius L.	Fabaceae	Gunj	Seeds	diarrhoea	Kumari *et al.,* 2011
Carissa carandas Linn.	Apocynaceae	Karonda	Fruits	jaundice	Kumari *et al.,* 2011
Cinnamomum tamala Nees & Eberm.	Lauraceae	Dalchini	Leaves, Bark	diarrhoea	Kumari *et al.,* 2011; Singh and Attri, 2014
Diclipetra bupleuroides Nees	Acanthaceae	Kulartore	Seeds, Leaves	dysentery	Kumari *et al.,* 2011
Musa paradisiaca Linn.	Musceae	Kela	Leaves, Stems, Fruits	dysentery	Kumari *et al.,* 2011; Singh and Attri, 2014
Plantago lanceolata Linn.	Plantaginaceae	Kashur-gula	Seeds	dysentery	Kumari *et al.,* 2011
Plantago major Linn.	Plantaginaceae	Isopgoal, Lahuryia	Seeds	dysentery	Kumari *et al.,* 2011; Pandey *et al.,* 2017
Roscoea procera Wall.	Zingiberaceae	Kakoli	Roots	jaundice	Kumari *et al.,* 2011; Pandey *et al.,* 2017
Satyrium nepalensis D. Don	Orchidaceae	Mishri	Roots	dysentery	Kumari *et al.,* 2011
Sesamum orientale Linn.	Pedaliaceae	Til	ND	dysentery, cholera	Kumari *et al.,* 2011; Singh and Attri, 2014
Smilax aspera Linn.	Smilaceae	Kukundara	Roots	diarrhoea	Kumari *et al.,* 2011
Terminalia alata Heyna ex Roth.	Combretaceae	Saij	Stems	dysentery, diarrhoea	Kumari *et al.,* 2011

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Thalictrum foliolosum DC.	Ranunculaceae	Mamiri	Roots	jaundice	Kumari *et al.,* 2011; Mehra *et al.,* 2014; Pandey *et al.,* 2017; Kumari *et al.,* 2012
Raphanus sativus L.	Brassicaceae	Muli	Whole Plant, Rhizome, Leaves	jaundice	Mehra *et al.,* 2014; Semwal *et al.,* 2010; Mathur and Joshi, 2012; Singh and Attri, 2014
Mentha piperita L.	Lamiaceae	Piperment	Leaves	typhoid	Mehra *et al.,* 2014
Citrus medica L.	Rutaceae	Lemon	Fruits	diarrhoea	Mehra *et al.,* 2014
Picrorhiza kurroa Royle ex Benth	Scrophulariaceae	Kutki	Roots	jaundice, dysentery	Mehra *et al.,* 2014; Semwal *et al.,* 2010
Solanum nigrum L.	Solanaceae	Makoi, Futkaiya, Giwai	Fruits, Whole Plant	dysentery, jaundice	Mehra *et al.,* 2014; Pandey *et al.,* 2017; Sharma *et al.,* 2011; Mathur and Joshi, 2012; Singh and Attri, 2014; Gaur and Sharma, 2011
Hedychium spicatum Sm.	Zingiberaceae	Van Haldi	Rhizome	diarrhoea	Mehra *et al.,* 2014
Tinospora sinensis (Lour.) Mierr.	Menispermaceae	Giloe	Bark	jaundice	Pandey *et al.,* 2017
Viola serpens Wall.	Violaceae	Banafsa	Whole Plant	jaundice	Pandey *et al.,* 2017
Sida cardifolia L.	Malvaceae	Denusha	Roots	dysentery	Pandey *et al.,* 2017
Geranium nepalense Sweet	Geraniaceae	Laljari	Roots	jaundice	Pandey *et al.,* 2017; Singh and Attri, 2014
Desmodium elegans DC.	Fabaceae	Chamlai, Bhatul	Roots, Whole Plant	cholera, dysentery	Pandey *et al.,* 2017; Singh and Attri, 2014
Albizzia chinesis (Osbeck) Merril in Amer.	Mimosaceae	Siris	Bark	dysentery	Pandey *et al.,* 2017
Potentilla fulgens Wall. Ex HK.f.	Rosaceae	Bajardantii	Roots, Leaves	dysentery	Pandey *et al.,* 2017
Randia tetrasperma (Wall. Ex Roxb.) Benth & Hook.f. ex Brandis	Rubiaceae	Ghari, Ghanaalo	Roots	jaundice	Pandey *et al.,* 2017; Singh and Attri, 2014
Valeriana hardwichii Wall. Ex Roxb	Valerianaceae	Sameo, Sumaya	Whole Plant, Roots	diarrhoea, jaundice	Pandey *et al.,* 2017; Gaur and Sharma, 2011
Valeriana wallichii DC.	Valerianaceae	Sameo	Roots	cholera	Pandey *et al.,* 2017
Plumbago zeylanica L.	Plumbaginaceae	Chitrak	Roots	dysentery, diarrhoea, jaundice	Pandey *et al.,* 2017; Sharma *et al.,* 2011; Gaur and Sharma, 2011
Symplocos crataegoides Buch-Ham.Ex D.Don	Symplocaceae	Lodh	Bark	dysentery	Pandey *et al.,* 2017

Table 2 Continue...

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Emblica officinalis Gaertn	Euphorbiaceae	Amla	Fruits	jaundice, dysentery, diarrhoea	Pandey *et al.,* 2017; Singh and Attri, 2014
Phyllanthus urinaria L.	Euphorbiaceae	Bhumiamla	Whole Plant	jaundice	Pandey *et al.,* 2017
Quercus leucotrichophora A. Camus	Fagaceae	Banj	Leaves, Fruits, Bark	diarrhoea, dysentery	Pandey *et al.,* 2017; Singh and Attri, 2014; Gaur and Sharma, 2011
Agave americana L.	Agavaceae	Rambans	Leaves, Roots	jaundice	Pandey *et al.,* 2017
Dioscorea deltoidea Wall. Ex Kunth.	Diosceraceae	Tarur	Rhizome	dysentery	Pandey *et al.,* 2017
Allium stracheyi Baker	Lilliaceae	Jambu	Leaves	jaundice	Pandey *et al.,* 2017
Asparagus curillus Buch-Ham.ex Roxb.	Lilliaceae	Kariu	Leaves	diarrhoea	Pandey *et al.,* 2017
Lannea coromandelica (Houttuyn) Merrill	Anacardiaceae	Jingan	Bark	diarrhoea	Sharma *et al.,* 2011
Terminalia chebula Retz.	Combretaceae	Heda	Fruits	dysentery, diarrhoea	Sharma *et al.,* 2011; Singh and Attri, 2014
Gnaphalium affine D.Don	Asteraceae	Bugla	Whole Plant	diarrhoea	Dangwal and Sharma, 2011
Saussurea obvallata (DC.) Edgew.	Asteraceae	Braham Kamal	Flowers	jaundice	Rana *et al.,* 2013
Plantago depressa Wild.	Plantaginaceae	Isabgol	Leaves, Seeds	diarrhoea	Rana *et al.,* 2013
Aconitum heterophyllum Wall. Ex Royle	Ranunculaceae	Ateesh	Tubers	diarrhoea, dysentery	Semwal *et al.,* 2010; Singh *et al.,* 2017
Brassica campestris L.	Brassicaceae	Sarshaon	ND	jaundice	Semwal *et al.,* 2010
Dactylorhiza hatagirea (D. Don)	Orchidaceae	Soo	Tubers	diarrhoea	Semwal *et al.,* 2010
Megacarpaea polyandra Benth.	Brassicaceae	Barmola	Leaves	dysentery	Semwal *et al.,* 2010
Rheum emodi Wall.	Polygonaceae	Archu	Roots	dysentery	Semwal *et al.,* 2010
Chenopodium album Linn.	Chenopodiaceae	Bathua	Whole Plant	jaundice	Mathur and Joshi, 2012
Curcuma longa	Zingiberaceae	Turmeric	Rhizome	jaundice	Kumar and Pandey, 2015
Taxus baccata Linn.	Taxaceae	Thuner	Leaves, Bark	jaundice	Kumari *et al.,* 2012; Singh and Attri, 2014
Baliospermum montanum Will.	Euphorbiaceae	NS	ND	jaundice	Kumari *et al.,* 2012
Celastrus paniculatus Will.	Celastraceae	Malkuni, Umjan	Seeds, Fruits	dysentery, diarrhoea	Kumari *et al.,* 2012; Gaur and Sharma, 2011
Coriandum sativum	Apiaceae	Dhaniya	Leaves, Seeds	diarrhoea	Sharma *et al.,* 2017
Rumex hastatus	Polygonaceae	Almoda	Whole Plant, Roots	dysentery, jaundice	Sharma *et al.,* 2017; Singh and Attri, 2014

Table 2 Continue...

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Acrous calamus Linn.	Acoraceae	Bach, Bauj	Roots, Leaves, Rhizome	dysentery, jaundice	Singh and Attri, 2014, Singh *et al.,* 2017
Carissa opaca Stapf . Ex. Haines	Apocynaceae	Karonda	Roots	jaundice, hepatitis	Singh and Attri, 2014
Garguga pinnata, Roxb	Burseraceae	Titmer	Leaves	diarrhoea	Singh and Attri, 2014
Cassia occidentalis Linn.	Caesalpiniaceae	Kasodi	Leaves, Bark	jaundice	Singh and Attri, 2014
Anaphalis contorta D. Doon. Hook. F. Kuntze	Compositae	Poth	Flowers, Leaves	diarrhoea	Singh and Attri, 2014
*Cicer arietinum*Linn	Fabaceae	Chana	Fruits	dysentery	Singh and Attri, 2014
Paris polyphylla, Smith	Lilliaceae	Satwa	Roots	diarrhoea	Singh and Attri, 2014
Toona ciliata Roem	Meliaceae	Tuni	Bark, Fruits, Leaves	dysentery	Singh and Attri, 2014
Premna barbata Wall.	Verbenaceae	Agneo	Bark, Leaves	diarrhoea	Singh and Attri, 2014
Viola canescens Wall. Ex. Roxb	Violaceae	Banafsa	Flowers, Leaves	jaundice	Singh and Attri, 2014
Citrus aurantiifolia (Christm) Swingle	Rutaceae	Kaagjii	Fruits	dysentery, diarrhoea	Singh *et al.,* 2017
Solanum khasianum C.B. Clarke	Solanaceae	Bhugundroo	Fruits, Roots	jaundice	Singh *et al.,* 2017
Flemingia vestita Benth	Fabaceae	Jungli Bhatya	Roots	dysentery	Gaur and Sharma, 2011
Meliotus indica (L.)	Fabaceae	Ban-methula	Leaves	dysentry	Gaur and Sharma, 2011
Litsea glutinosa (Lour). Robin	Lauraceae	Singrau	Bark, Fruits	dysentery, diarrhoea	Gaur and Sharma, 2011
Ficus auriculata Lour	Moraceae	Timla	Fruits	dysentery	Gaur and Sharma, 2011
Coix lacryma-jobi L.	Poaceae	Sankuru	Fruits	dysentery, diarrhoea	Gaur and Sharma, 2011
Persicaria capitata (Buch-Ham) H.Gross	Polygonaceae	Kaflya, Dhadhura	Roots	dysentery	Gaur and Sharma, 2011
Solanum suratense Andr.	Solanaceae	Konkaru	Fruits, Flowers	diarrhoea	Gaur and Sharma, 2011
Engelhardtia spicata Lesch. Ex Blume	Juglandaceae	Mowa	Bark	diarrhoea	Malik *et al.,* 2015
Pavetta tomentosa Roxb. Ex J.E. Smith	Rubiaceae	Damaya	Leaves, Roots	jaundice	Malik *et al.,* 2015
Spermadictyon sanveolens Roxb	Rubiaceae	Padaru	Roots	diarrhoea, cholera	Malik *et al.,* 2015
Rumex nepalensis Sprengel	Polygonaceae	Pahadipalak	Roots, Leaves	dysentery	Malik *et al.,* 2015
Rosa brunonii Lindley	Rosaceae	Pup Kunja	Leaves, Flowers	diarrhoea	Malik *et al.,* 2015

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 Bageshwar 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 hill 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 Uttaranchal, 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.

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