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Review Article

Herbal potential of some plants from Shivalik hills of H.P. Northwestern Himalaya for treatment of waterborne diseases: A Review

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Abstract: Water pollution is the significant pollution of rural areas and even in the cities pollution of water occurs when pollutants or contaminants are inducted into the natural surroundings intentionally or unintentionally. Water pollution is the discharge of impurities into water bodies like chemicals, microorganisms, radioactive energy, and heat. These substances are called water pollutants and obstruct the essential water utilization or the natural working of the ecosystem. The contaminated or polluted water causes many human diseases such as cholera, diarrhea, dysentery, typhoid, jaundice, polio (infantile paralysis), and trachoma (eye infection). Himachal Pradesh is a hilly state which is full of forests with characteristic medicinal wealth and floristic diversity. Mostly the peoples of Himachal Pradesh live in the rural areas and the vicinity of the forest. They are having a great reservoir of traditional knowledge regarding the use of local plants from the forest to treat various health problems. This study emphasizes the conventional use of some plants from the forest of Shivalik hills of Himachal Pradesh, the North-Western Himalayan region, for the cure of diseases that occurs because of water pollution.

Keywords: Contaminated water; Ethnomedicinal; Himachal Pradesh; Shivalik Hills; Water pollution

Introduction

Water is one of the crucial substances present on the earth and our environment. Water is a basic component of our life. Without water, no life would be possible on earth. All animals and plants must have water to survive. Water constitutes around 71% of the surface of the earth, and oceans contained approximately 96.5% of all water on earth (Karikari & Ansa, 2006). Although water is found in abundance on the earth, however, drinkable freshwater is not ever procurable at the required time or in the required area for the use of humans and ecosystems. Water is an invaluable fundamental resource of life that is vital to life. It is found that water is present in nature as runoff and groundwater in various sources and forms, that are seas oceans, streams, rivers, ponds, lakes, wells, springs, and boreholes. Rivers are considered the earliest bodies of water on the earth (Higler, 2012). The surface water of streams, lakes, and rivers, which has been an inexpensive water source used by the peoples for their households' purposes. These water resources are polluted with household's, agrarian's, and factories's manufacturing waste and is the possibility of giving rise to water-borne diseases (Ojekunle, 2012 & Ayeni, 2014). It is found that there is a more significant relationship among pollution and health ailments. The microorganisms responsible for

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causing diseases are known as a pathogen which is spreading diseases directly among humans. Many waterborne diseases are spread from man to man (Halder & Islam, 2015).

The health risk which is associated with polluted water includes – respiratory diseases, cancer, diarrhea, neurological disorder and cardiovascular diseases (Ullahs *et al*., 2014). The blue baby syndrome is caused by nitrates or chemicals comprising nitrates which are pollutants of the water. (Krishanan & Indu, 2006). Deaths caused due to cancer are higher in rural areas than urban because the peoples of urban areas treated water drinking. In contrast, the people of rural areas use unprocessed and untreated water due to a lack of such facilities. Therefore, poor people and rural people are at a greater risk of waterborne diseases due to improper sanitation hygiene and water supply (Jabeen *et al*., 2011). There are around 44 million people in India who have been troubled by the poor water quality results from the pollution of water. Some deadly pathogen also pollutes the water even at lower concentrations.

Types of Water Pollution: There are mainly two types of water pollution- groundwater pollution and surface water pollution. Groundwater is about 30 times more quantity than run-off water available on this planet. However, groundwater is less prone to water pollution. The pollution of groundwater is primarily due to septic tanks, industries like textile, chemical, and tanneries, etc., and deep well injection and activities associated with mining. The groundwater gets with substances like fluoride, arsenic, and nitrate, which causes serious health problems. The use of pesticides and agricultural fertilizers are the prevalent source of groundwater pollution. Surface water pollution is that pollution which founds on the earth's surface water. They include lagoon, rivers, and oceans. The contamination of surface water resulting from mixing or dissolving of water with the pollutants. It can be accidental, such as oil spills in the oceans and eliminating industrial wastes into the rivers or sea.

Sources of Water Pollution: The water pollutant comes from different sources such – garbage discharges into the river, industrial effluents flow into the river without any pretreatment, surface runoff from agricultural land where chemical fertilizer, pesticides, insecticides, and manure used (Diwedi, 2017). Therefore, the presence of these pollutants in the river, water becomes hazardous for drinking purposes. About 1500 substances have been listed in the freshwater ecosystem, which includes acids and alkalies, anion (e.g., sulfide, cyanide), detergent, domestic sewage and farm manure, water utilized in food processing, ammonia, heat, metals (cadmium, zinc, lead), nutrients (phosphates, nitrates), oils and oil-dispersants, organic toxic wastes (formal aldehyde phenols), pathogen, pesticides, radio nucleotides and polychlorinated biphenyl along with oxidizing material, detergents, nutrients, metals, pathogen (disease-causing organisms) present in sewage coming from domestic use and several other compounds (Tripathi *et al*., 1990).

Waterborne diseases (Diseases caused by water pollution): Microorganisms play a significant role in water quality and microorganisms concerned with waterborne diseases - *Salmonella* sp., *Escherichia coli, Vibrio cholera,* and *Shigella* sp., (Adentude & Glover, 2010). All these cause typhoid, fever, diarrhea, dysentery, gastroenteritis, and cholera. Water pollution becomes most dangerous when fecal matter enters the water supply. Many diseases are sustained in the population by the way of fecal-oral transmission route, in the course of

that pathogens are only left through human faces (Singh & Gupta, 2016; Adentude & Glover, 2010). It is found that there is a greater association between pollution and health-related issues. The disease-causing microorganisms are known as a pathogen which is spreading diseases directly among humans. Many waterborne diseases are spread from human to human (Halder & Islam, 2015). The health risks of water pollution comprise bronchial diseases, cancer, dysentery, neurological disorder, and cardiovascular diseases (Ullahs *et al*., 2014). The nitrogenous chemical which pollutes water is responsible for the blue baby syndrome (Krishanan & Indu, 2006). Deaths, which are caused because of cancer is more in the rural region than urban because the people of the urban region use pure water after treatment for drinking while the people of rural areas use unprocessed and untreated water because of the absence of such provisions. Thus poor people and rural people are a greater risk of waterborne diseases due to improper sanitation, cleanliness, and supply of water (Jabeen *et al*., 2011).

Types of waterborne disease caused by contaminated water: Untreated, contaminated, or polluted water give rise to many bacterial infections such as diarrhea, cholera, water or bloody diarrhea, abdominal cramps, typhoid, nausea, and vomiting. *Camphylobacter jejuni* is mainly responsible for spreading bacteria 4% to 15% worldwide. The symptoms of this diarrhea comprise fever, headache, nausea, and abdominal pain. Cholera is caused when toxins are produced in the digestive tract. The symptoms of this disease are watery diarrhoea, nausea, and vomiting. Watery diarrhoea causes water loss and renal failure. Shigellosis is a waterborne bacterial disease and is caused due to bacteria named *Shigella*. This bacterium affects the alimentary canal of humans and destroys the lining of the intestine. The common symptoms are watery or bloody diarrhoea, nausea, vomiting, and abdominal cramps. Salmonellosis is a waterborne bacterial disease caused by Salmonella bacteria found in polluted water, resulting in intestinal inflammation and death occurs (Haseena *et al*., 2017).

Viral-waterborne diseases: There are many waterborne diseases caused by viruses. Viral hepatitis, a disease related to the liver caused due to polluted water; jaundice, appetite loss, discomfort, high fever, and fatigue are symptoms of hepatitis (Haseena *et al*., 2017). Encephalitis is an inflammatory spread by the bite of infected Culex mosquitoes. The culex mosquitoes lay their egg on polluted water. The main symptoms of Encephalitis are high fever, headache, muscle stiffness, confusion, and in serious cases, paralysis and coma. Polio is a waterborne viral disease and caused by the Poliomyelitis virus. The symptoms of poliomyelitis are - sore throat fever, nausea, constipation, diarrhoea, and sometimes paralysis (Haseena *et al*., 2017). Gastroenteritis is also resulted from polluted water caused by viruses including rotaviruses, adenoviruses, calicivirus and Norwalk virus. The disease's main symptoms are – vomiting, headache, and fever (Haseena *et al*., 2017).

Parasitic waterborne diseases: Cryptosporidiosis is a parasitic waterborne disease caused by *Cryptosporidium parvum*. It is a global disease having ordinary symptoms comprising diarrhea, large or watery bowel, stomach pangs, and stomach upset. This parasite is mainly responsible for causing vomiting and diarrhea in humans (Ballister *et al*., 2001). Giardiasis is common disease produced by the parasite *Giardia lambia*. In this disease, the lining of intestine can become injured. People suffer from giardiasis, having symptoms such as

bloating, diarrhea, excess gas, and loss of weight (Haseena *et al*., 2017).

Most of the population of Himachal Pradesh live in tribal and rural areas. So, water pollution is a major problem in rural areas due to a lack of sanitation and hygienic condition in rural areas. Thus the waterborne disease is commonly occurring in rural areas. The elderly peoples and traditional healers of the study area have good faith in the herbal potential of local plants of forests to treat various health problems, including waterborne diseases. This study reveals the exploration of the ethnomedicinal importance of plants of Shivalik hills of Himachal Pradesh to treat infections caused by water pollution.

Materials and Methods

North-Western Himalayan of India is known for its wide variety of flora and the use of traditional home remedies is quite prevalent in this region so it an important part of the folk medicine in the Himalayan region (Kharwal and Rawat, 2017). Himachal Pradesh is a beautiful state which lies in the North-Western Himalaya. This state is well known for the scenic beauty of forestland, hills, valleys, and lakes, which are full of materials having wide applicability and significance in human values and culture. Shivalik or lower hills of Himachal Pradesh is known as "Manak Parbat" from the olden days symbolizes the "tresses of Shiva". Shivalik hills in Himachal Pradesh include Kangra, Hamirpur, Bilaspur, Una, and lower regions of Mandi, Sirmaur, and Solan. The height of these hills varies from 350 m to 1500 m above sea level (Balokhra, 2002). This paper emphasizes the herbal potential of some plants of the Shivalik hills of "Himachal Pradesh'' for the treatment of diseases caused by water pollution.

During this study, the exploration trips were carried out in some rural areas of each district of Shivalik hills to collect first-hand information on plants' herbal potential for the treatment of various health problems, including waterborne diseases. The related information was collected from elderly and experienced local people, local Vaids, and traditional healers during this survey. Phondani *et al*., (2010) adopting three approaches, i.e. an interview-based approach, inventory-based approach, and interaction and discussion approach with communities (Kharwal and Rawat, 2012). The information collected was verified by cross-checking it from the people of the neighborhood by repeating the same questions and information separately. The data is confirmed from a different group of people from a diverse community group in other localities of the study area.

Results

The collected information in the present investigation revealed the importance of different plants of Shivalik hills in Himachal Pradesh, a part of the North-Western Himalaya, to cure the diseases caused by water pollution. The plants are given systematically from A to Z along with their scientific name, family, the local name part/parts used, and the ethnomedicinal use. This study includes 55 plants that are used for the treatment of waterborne diseases belonging to 32 different families (see Table 1). Among these 32 families, the predominant families are Fabaceae with 11 plant species, Rosaceae with 5 plant species, Euphorbiaceae, Rutaceae, Solanaceae with 3 plant species Lamiaceae and Moraceae with 2 species each. Among parts of plants the fruit of 14 plant species, the roots of 12 plant species, leaves of 11 plant species, whole plant material of 7 plant species are used. Flower, bark, and seeds of 4 plant species each and stem, tuber, and inflorescence of 1 species are used to treat waterborne diseases caused by water pollution (see Figure 1).

Table 1: Ethno-medicinal uses of plants from the studied region to cure the diseases caused by water pollution

S. No.	Plants Name	Family	Local Names	Parts Used	Ethno-medicinal Uses
1.	*Acacia catechu* (L.F.) Willd.	Fabaceae	Khair	Bark	Crushed dried powder of bark is useful in case of diarrhoea
2.	*Achyranthes bidentata* Blume.	Amaranthaceae	Umbalkanta	Whole plant	Whole plant material extract is useful in case of cholera
3.	*Aegle marmelos* L.	Rutaceae	Bil, Bilpatri	Fruit	Fruit juice with gur (jaggery) is given two time in a day for the treatment of diarrhoea and dysentery
4.	*Albizia lebeck* (L.) Benth.	Fabaceae	Saras, Sirinh, Sirinsh,	Bark	The dried bark is crushed and ground to make powder. This powder is used in the treatment of diarrhoea
5.	*Andrographis paniculata* (Burm.f.) Wall.ex Nees	Acanthaceae	Kalmegh	Roots and leaves	The decoction of dry roots and leaves used in the treatment of viral hepatitis, malaria and dysentry
6.	*Argemone mexicana* L.	Papaveraceae	Bharbhand	Whole plant	The sap, which is yellowish in colour extracted from the plant, is used to cure the hepatitis and jaundice. Extract of whole plant is useful for Hepatitis and Jaundice
7.	*Asparagus adscendens* Roxb.	Asparagaceae	Sansfai, Safedmusli	Root	Root decoction is beneficial for the treatment of dysentery
8.	*Atrocarpus integrifolia* L.	Moraceae	Katahal	Fruit	Fruit when ripe is used to cure dysentery
9.	*Bauhinia variegata* L.	Fabaceae	Kachnar, Karyala	Bud	Buds of the plant are dried and then crushed to make powder. 1 teaspoon of this powder is used three times in a day to check diarrhoea, dysentery
10.	*Berberis lycium* Royle.	Berberidaceae	Kashmal, Doruhaldi	Leaves	The delicate and tender leaves of this plant are chewed in case of dysentery
11.	*Bombax ceiba* L.	Malvaceae	Semal, Kuku	Flower	Flowers are dried and crushed to make powder. This powder is given twice in a day for 4-5 days to treat the dysentery and diarrhoea
12.	*Butea monosperma* (Lam.) Taub.	Fabaceae	Palash, Palah	Flower	Dried flower extract is used in the treatment of diarrhoea

13.	*Cajanus cajan* (L.) Millsp.	Fabaceae	Arahar, Chana	Leaves and seeds	The crushed dried powder prepared from the leaves and seeds is given with luke warm water to cure Hepatitis and Jaundice
14.	*Calotropis gigantea* (L.) W.T. Aiton.	Asclepediaceae	Aak, Safedaak	Root	Crushed dried powder of root is taken with luke warm water in case of dysentry
15.	*Chenopodium ambrosides* L.	Chenopodiaceae	Dangar Ajwain	Aerial part (stem, leaves and flowers)	Paste of aerial parts grinded in water is used to treat the amoebic dysentery
16.	*Citrus limon (*L.) Burm. F.	Rutaceae	Nimbu, Nimboo	Fruit	Juice extracted from fruit is taken thrice daily to check vomiting and diarrhoea
17.	*Cordia dichotoma* G. Forst.	Boraginaceae	Lasuda, Lasura	Inflorescnce and fruits	Infloresence and fruit of this plant is cooked as a vegetable and considered good for dysentery
18.	*Dalbergia sissoo* Roxb.	Fabaceae	Tahli, Shisham	Leaves	Juice extracted from leaves mixed with sugar and curd is useful for the treatment of blooded dysentry
19.	*Datura fastuosa* L.	Solanaceae	Kaladhatura	Root	Dried powder of roots is used to cure diarrhoea
20.	*Desmodium gangeticum* (L.) DC.	Fabaceae	Shalparni, Kusha	Root	A decoction of the root of this plant is useful in case of diarrhoea and vomiting
21.	*Discorea bulbifera* L.	Discoreaceae	Tarad	Tuber (underground stem)	Crushed and dried tuber extract is used to treat the diarrhoea and dysentery
22.	*Euphorbia hirta* L.	Euphorbiaceae	Doodhi	Whole plant	Whole plant material extract is used for the treatment of dysentery
23.	*Ficus religiosa* L.	Moraceae	Peepal	Root	Powder of dried roots is used to cure cholera, diarrhoea and dysentery
24.	*Jatropa curcas* L.	Euphorbiaceae	Jamnota, Jablotha	Leaves	Decoction of dried leaves is used two times in a day upto three days for curing diarrhoea
25.	*Mallotus phiilippensis* (Lam.) Muell. Arg.	Euphorbiaceae	Kamal	Root	Small roots of this plant are beneficial for Poliomyelitis when these roots are dried on the neck
26.	*Mentha pipertia* L.	Lamiaceae	Pipermint	Leaves	extracted Juice of fresh leaves is useful for curing the diarrhoea
27.	*Moringa oleifera* Lam.	Moringaceae	Suhanjan	Leaves	A decoction of leaves is beneficial in case of typhoid and malaria

28.	*Murraya koenigii* (L.) Spreng.	Rutaceae	Kadi-Patta, Gandhela	Leaves	Chewing of leaves is beneficial in diarrhoeal treatment.
29.	*Musa paradisiaca* L.	Musaceae	Kela	fruit	Fruit of this plant has antidysentric property and used to cure dysentery
30.	*Nicotiana tabacum* L.	Solanaceae	Tambaku	Leaves	Dried leaves powder extract with water is beneficial for abdominal pain and dysentery
31.	*Ocimum basilicum* L.	Lamiaceae	Bhabri	Leaves	A decoction prepared from leaves is beneficial for dysentery and typhoid
32.	*Oroxylum indicum* (L.) Kurz.	Bignoniaceae	Seenak, Tatpalanga	Bark and Root	Crushed and ground dried powder of bark and root is useful in dysentry and diarrhoeal treatment
33.	*Oxalis corniculata* L.	Oxalidaceae	Khatimithi, Changerimalori	Entire plant	Whole plant extract with salt is given to a patient of dysentery
34.	*Phyllanthus niruri* L.	Phyllanthaceae	Bhumi ambla	Root	Decoction of root is useful in case of treatment of hepatitis and jaundice
35.	*Pistacia integerrima* J.L. Stewart ex. Brandis.	Anacardiaceae	Kakarsinghi	Fruit	Dried fruit powder is given upto seven days to cure Hepatitis and Jaundice
36.	*Plantago lanceolata* L.	Plantanginaceae	Safed isabgol	Seed	Powder of seed is beneficial in constipation and dysentery problems
37.	*Plumbago zeylanica* L.	Plumbaginaceae	Chitra	Root	Decoction of root is useful in case of diarrhoea
38.	*Pongamia pinnata* (L.) Pierre.	Fabaceae	Karanj, Put-Karanj	Whole plant	Decoction of whole plant material is useful in case of dyspebsis and diarrhea
39.	*Prunus amygladus* Batsch.	Rosaceae	Badam	Fruit	Decoction is prepared from the dried fruit is used to cure dysentery in small babies
40.	*Prunus domestica* L.	Rosaceae	Aloobhukhara, Plum	Fruit	Fruit is beneficial to cure dysentery. Extract prepared from the dried fruit of this plant alongwith fruit of *Tamarindus indica* by soaking these in water overnight. Extract mixed with sugar is given in morning time for curing Hepatitis and Jaundice
41.	*Pyrus communis* L.	Rosaceae	Nakh, Nashpati	Fruit	Fruit has anti dysenteric and antidiarrheal properties to cure these problems

42.	*Pyrus pashia* Buch. & Ham. ex D. Don	Rosaceae	Kainth	Fruit	Black pepper(*Piper nigrum*) mixed with fruit pulp of this plant is given two times in a day up to three consecutive days to check dysentery
43.	*Quercus glauca* Thunb.	Fagaceae	Ban	Bark	Extract prepared from dried bark powder with water is useful in diarrhoea and dysentery
44.	*Rauwolfia serpentina* (L.) Benth. ex Kurz.	Apocynaceae	Sarpganda	Whole plant	Decoction of entire plant material is beneficial for cholera, dysentery and diarrhoea
45.	*Rubus ellipticus* Smith.	Rosaceae	Akha, Rasberry	Ripe fruit	Ripe fruits are used in case of constipation because of ripe fruit is laxative. The paste of young fruit is beneficial to cure gastritis, dysentery and diarrhoea
46.	*Saraca indica* L.	Fabaceae	Ashok	Flower	Decoction preparation from flowers is beneficial in curing the gastroenteritis alongwith othe gastrointestinal problems
47.	*Solanum nigrum* L.	Solanaceae	Makoi	Fruit	Ripened Fruits have antidiarrheaL potential
48.	*Syzygium cumini* (L.) Skeel.	Myrtaceae	Jamun	Seed	Dried seed powder of this plant is beneficial for diarrhoea, dysentery and other digestive problems
49.	*Tamarindus indica* L.	Fabaceae	Imli	Root	Decoction of root is effective in curing jaundice and hepatitis
50.	*Taraxacum officinale* Weber. ex Wiggins.	Compositae	Dulal, Dudhli	Whole plant	Whole plant material id beneficial for the treatment of Hepatitis and Jaundice
51.	*Terminalia chebula* Retz.	Combretaceae	Harad	Fruit	One teaspoon of powdered fruits with seeds of saunf (*Foeniculum vulgare*) is fried in desi ghee, which is taken daily one with hot water to check dysentry
52.	*Trigonella foenum-graecum* L.	Fabaceae	Methi	seed	Decoction prepared from dried seed is beneficial for the treatment of gastroenteritis

53.	*Vigna vexillata* L. A. Rich.	Fabaceae	Baker, Bel,	Root	Decoction of its root along with turmeric (raw) and roots of bankakadi is given two times in a day up to a week is effective in curing cholera and stomach pain
54.	*Viola odorata* L.	Violaceae	Banaksha	Whole plant	Whole plant extract is useful for Hepatitis and Jaundice
55.	*Vitis vinifera* L.	Vitaceae	Angor	Fruits	The ripe fruit is useful in case of cholera

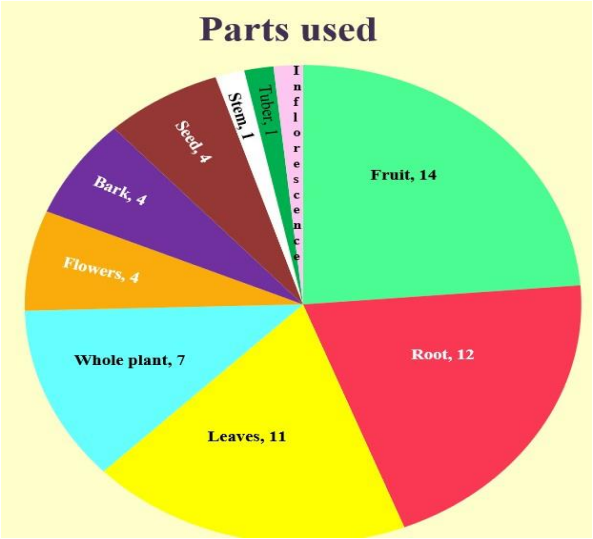

Figure 1. Pie Chart showing different plant parts used for waterborne diseases

Discussion

Plants for human beings are an old practice as human civilization and the human race itself. However, the accumulation of knowledge about the usage of plants is co-evaluated along with the development of human beings by the experimental practices of using plants through succeeding generations. The people in the past would have suffered from time to time due to the different disease outbreaks like an endemic epidemic, and chronic diseases apart from other ailments (Hamayun, 2003). The study regarding traditional knowledge of the plants related to the treatment of various diseases, including water-borne diseases such as dysentery, diarrhea, gastroenteritis, hepatitis, typhoid, has been carried out by Gariala *et al.,* (2013), Shanmugam *et al.,* (2011), Kumar and Chander (2019), Kumar *et al.,* (2016). The traditional health Practitioners and local people in communities of studied areas collected the medicinal plants from their natural habitat at different seasons and prepared the herbal products. The plant parts directly and processed plant parts are taken to treat diarrhea, dysentery, cholera, hepatitis, and other waterborne diseases. Diarrhea and dysentery are the most common diseases prevailing among the tribal and rural peoples of the study area due to their contaminated water. The use of roots and leaves of *Andrographis paniculata*, flowers of Bombax ceiba, inflorescence and fruits of Cordia dichotoma, roots of Ficus religiosa, roots of Plumbago zeylanica and bark of Quercus glauca, etc. for the treatment of dysentery and diarrhea is a new record in the study area because such species have not been reported in the study area earlier for controlling dysentery and diarrhea as waterborne diseases, so, such plants have given due attention for conservation.

Conclusion

It is concluded that the rural or indigenous people of the Shivalik hills of Himachal Pradesh of North-Western Himalaya have an excellent command of traditional knowledge regarding the utilization of local plants to treat various diseases. But this tradition is not documented yet. It is orally transferred from one generation to another for the

documentation of the traditional knowledge regarding the utilization of plant resources for various health problems. Due to urbanization, modernization, and advances in technology, there is massive destruction of wildlife due to their habitat loss by man-induced activities such as road, building, and industrial development, etc. Due to this development work, some plant species of forests become extinct, and some are in danger of extinction and threatened. Therefore, it is necessary to conserve plant species. So, conservation and domestication of plant species should be the steps required for protecting those plant species, which are essential from the herbal point of view to study their potential for curing the different health-related problems.

References

1. Abbasi, Khan, Ahmad, Zafar, Mohammad and Sultana, S. "Medicinal plants used for the treatment of jaundice and Hepatitis based on socio-economic documentation". African Journal of Biotechnology 8.8 (2009): 1643-1650.

2. Abbasi, Khan, Ahmad, Zafar, Jahan and Sultana S. ''Ethnopharmacological applications of medicinal plants to cure skin diseases and in folk cosmetics among the tribal communities of North-West Frontier Province Pakistan'' Journal of Ethnopharmacolology 128.2 (2010): 322-35.

3. Acharya, Patra, and Prashant, K. "Evaluation of the antimicrobial activity of some medicinal plants against enteric bacteria with particular reference to multidrug-resistant Vibrio cholera". Tropical Journal of Pharmaceutical Research 8.3 (2009): 231-237.

4. Adentude and Glouer, R.L.K. "Bacteriological quality of Borhole water used by students of university for the development studies, Naurongo Campus in Upper-Eastern Region of Ghana". Current Research Hournal of Biological sciences 2.6 (2010): 361-364.

5. Ayeni, J.F.N. Salinity dissolves oxygen, pH, and surface water temperature condition. Advanced Journal of food and Technology 2.1 (2014): 36-40.

6. Ballister and Sunyer, J. Challenges to public health in the new millennium. Journal Epidemial Community Health 54 (2000): 2-5.

7. Balokhra, J.M. The Wonderland Himachal Pradesh. HG Publication. New Delhi (2002).

8. Currie, Joshua, and Katherine, M. "Something in water; contaminated drinking water and infant health". Canadian Journal of Economics 46.3 (2013): 791-810.

9. Devi, Gupta and Singh, M. "Ethnomedicinal uses of plants belonging to Fabaceae and Solanaceae of Hamirpur district (Himachal Pradesh)". International Journal of Scientific and Research Publication 2.1 (2012): 1-4.

10. Dwivedi, A.K. "Researches in water pollution: A Review". IRJNAS (International Research Journal of Natural and Applied sciences 4.1 (2017): 118- 142.

11. Environmental Risk Assessment and Remediation (2017) Vol. 1 (3).

12. Gariala, Sharma, Gaur, Siddiqui and Painuli, R.M. "Plant used for the treatment of dysentery and diarrhoea by Bhoxa community of district Dehradun, India". J. Ethnopharmacal 150.3 (2013): 989-1006.

13. Halder and Islam, N.M. Water pollution and its impact on the human health. Journal of environment and human 2.1 (2015): 36-46.

14. Hamayun, M. "Ethnobotanical studies of some useful shrubs and trees of district Baner, NWFP, Pakistan". International Journal of Ethnobotanical leaflet 1 (2003): 1-17.

15. Haseena, Malik, Faheem, Arshad, Asif, Lulfiqar, and Hanif, J. "Water pollution and Human health" (2017).

16. Higler, L.**N.G. "**Fresh surface water Biology and Biodiversity of river system". ALTERRA, Wageningen, the Netherland. Encyclopedia of Life support system (EOLSS) (2012): 233-242.

17. Igberase and Ogbale, O.O. "Ethnomedicinal survey of the plants used in the treatment of typhoid and its complication in north-east local government area Uromi". 14.2 (2018): 175-188.

18. Jabeena, Mehmood and Tariq, B. "Health impact caused by poor water and sanitation in district Abbatabad". 23.1 (2011): 47-50.

19. Karikari and Ansa-Asare, O.D. "Physiochemical and microbial water quality assessment of Dehsu river of Ghana, West Africa". Journal of Applied Ecology 10 (2006):87-100.

20. Katoch, Arbeen and Satanaryan, M. "To study the ethnobotany and angiospermic diversity of Kangra district (Himachal Pradesh)". International Journal of Advances in Agricultural Science and Technology 4.10 (2017): 1-7.

21. Kharwal and Rawat, D. "Ethnobotanical important climber and lianas of Shivalik hills, Himachal Pradesh (India)". International Journal of the Herbal Medicine 5.1 (2017): 46-49.

22. Krishnan and Indu, R. "Ground water contamination in India. Discussing physical process, health and socio-behavioural dimensions". 1WM1-Tata, Water Policy Research Prpgrammes and India. (2006).

23. Kumar and Chander, H. "Traditional usage of Ethnomedicinal plants of the Sikander Hills range in mandi district of Himachal Pradesh, India". Asian Journal of Advance Basic Science 7.2 (2019): 42-49.

24. Kumar and Choyal, R. "Traditional use of some plants of Hamirpur District of Himachal Pradesh for the treatment of Jaundice, Hepatitis and other liver disorders". International Journal of Theoretical and Applied Sciences 4.2 (2012): 201- 205.

25. Kumar and Kumar, P. "Medicinal plant diversity in Tungal valley of district Mandi, Himachal Pradesh (India)". Proceeding of National Conference on "Advances in Basic and Applied Sciences (ABAS-2014) in Asian Journal of Advance Basic Science 2.3 (2014): 103-108.

26. Kumar and Sharma, B. "Commonly used medicinal plants in tehsil Baijnath, district

27. Kangra, Himachal Pradesh of India". Research in Pharmacy 4.5 (2014): 11-15.

28. Kumar, Choyal and Kumar, S. "Ethnomedicinal important plants of Hamirpur (Himachal Pradesh) India". Lap Lamber Academic Publisher. (2015). ISBN: 978-3-659-78491-1-0, 1- 155.

29. Kumar, Kumar, Saklani and Kumar, S. "Documentation of traditional knowledge about medicinal value of some wild edible plants resources of Hamirpur district

(H.P.)". Journal of Medicinal plant Studies 7.6 (2019): 175-178.

30. Kumar, Kumar, Sharma, and Sharma, S. Ethnomedicinal uses of some plants in the treatment of constipation, diarrhea, dysentery and other stomach or digestive disorder from district Hamirpur (Himachal Pradesh). International Journal Curr. Res. Biosci. Plant Biol. 2.11 (2015): 36-40.

31. Kumar, Samant, and Puri, S. "Diversity, distribution, indigenous uses and conservation of the medicinal plants in central Himachal Pradesh". North Western Himachal Journal of Medicinal plant Studies 6.5 (2018): 45-68.

32. Maity, Pradhan, and Chauhan, A.S. "Folk uses of some medicinal plants from North Sikkim". Indian Journal of Traditional Knowledge 3 (2004): 66-71.

33. Thakur, Asrani, Thakur, Sharma, Patil, Lal and Prakash, O. "Observation on traditional usage of ethnomedicinal plants in human and animals of Kangra and Chamba districts of Himachal Pradesh in Northern Western Himalaya, India'' Journal of Ethnopharmacology 191 (2016): 280-300.

34. Mir, Khare, and M. Jan. "A Study on the Use of Medicinal Plants for the Treatment of Diarrhoea and Dysentery in Khag Tehsil of District Budgam of Jammu and Kashmir". Journal of Medicinal Herbs and Ethnomedicine 7 (2021):6-10.

35. Mishra and Bhushan**.** **"**Perspective of potential plants for medicine from Rajasthan, India". International Journal of Pharmacy, Research 7.1 (2016): 1-9.

36. Kadir, Karmoker, Alam, Jahan, Mahbub and Mia, M. M. K. "Ethnopharmacological Survey of Medicinal Plants Used by Traditional Healers and Indigenous People in Chittagong Hill Tracts,

37. Snakebite", Evidence-Based Complementary and Alternative Medicine 2015 (2015): 23.

38. Pathak, A. K. "Water pollution and treatment". International Journal of Environmental Engineering and Management 4.3 (2013): 191-198.

39. Prakash and Agarwal, A. "Traditional uses of ethnomedicinal plants of lower foothills of Himachal Pradesh". Indian Journal of Traditional Knowledge 9 (2010): 519-521.

40. Raghuvanshi, Dhalaria, Sharma, Kumar, Kumar, Valis, Kuča, Verma, and Puri, S. ''Ethnomedicinal Plants Traditionally Used for the Treatment of Jaundice (Icterus) in Himachal Pradesh in Western Himalaya-A Review'' Plants (Basel, Switzerland) *10*.2 (2021): 232.

41. Rana, Bhatt, Lal, Prakash and Uniyal, S. K. Use of medicinal plants for treating different ailments by the indigenous people of Churah subdivision of district Chamba, Himachal Pradesh, India. Environment, Development and Sustainability 23(2021): 1162–1241.

42. Rawat, and Kharwal, A. ''Ethnobotanical information on Sapium insigne (Royle) Benth.: A conserved plant of Shivalik hills, India'' Bangladesh Journal of Plant Taxonomy 17.1 (2010): 97-99.

43. Kharwal and Rawat, D. S. ''Ethnobotanical notes on indigenous herbal shampoos of Shivalik hills, Himachal Pradesh (India)'' Plant Sciences Feed 2.6 (2012): 88-90.

44. Shabnam Shaheen, Mushtaq Ahmad, Nidas

Haroon. "Edible Wild Plants: An alternative approach to food security" Springer Science and Buisness Media LLC, 2017.

45. Shanmugam, Annadurai, and Rajendran, K. "Ethnomedicinal plants used to cure diarrhoea and dysentery in Pachalour hills of Dindigul district in Tamil Nadu, Southern India". Journal of Applied Pharmaceutical Science, 1.8 (2011): 94- 97.

46. Sharma and Rana, J.G. Traditional medicinal use of plants of Himachal Hills. J.Econ. tax. Bot. 23.1 (1999): 173-176.

47. Sharma, Thakur, Verma, Kumari, Sharma, and Araya, V. "Ethnomedicinal wisdom among the local tribes in Hamirpur valley, Himachal Pradesh, India". Journal of Medical and Allied Science 2.2 (2018): 84-88.

48. Singh and Gupta, A. "Water pollution sources, effects and control". Article published, https:/www.researchgate.net/pollution/3212896 37 (2017).

49. Tripathi and Dwivedi, A.K. Pollution tolerance and distribution pattern of plants in surrounding areas of coal-fired industries. Journal of Environmental Biology 28.1 (2007): 257-263.

50. Tripathi, Mishra, Pandey, and Srivastava. "Effect of tissue N-content on decomposition of water hyacinth (*Eichhornia crassipes*) (Mart). Salm. Geobios 17.2-3 (1990): 67-69.

51. Ullahs and Shafique, M. An Integrated approach for quality assessment of drinking water using GIS- A case study of lower Dir. Journal of Himalayan earth science 47.2 (2014): 163-174.

52. Verma and Chauhan, N.S. Indigenous medicinal plants knowledge of Kunihar forest division, district Solan. Indian Journal of Traditional knowledge 6.3 (2007): 494-497.

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