Journal of Chemical Health Risks

www.jchr.org

JCHR (2024) 14(2), 939-944 | ISSN:2251-6727

Exploring the Indian Himalayan Plants with Antimicrobial Activity: A Comprehensive Review

Mrs.Oviya Priya. I[*1], Dr. Alice Peace Selvabai[*1], Dr. Priyadarshini Shanmugam[*2], Dr. Ankush Chauhan[*3]

*1PhD Research Scholar, Department of Microbiology, Chettinad Hospital and Research Institute, Chettinad Academy of Research and Education, Kelambakkam, Chengalpattu district, Tamil Nadu-603103, India.

* Professor, Department of Microbiology, Chettinad Hospital and Research Institute, Chettinad Academy of Research and Education, Kelambakkam, Chengalpattu district, Tamil Nadu-603103, India.

* Professor & Head, Department of Microbiology, Chettinad Hospital and Research Institute, Chettinad Academy of Research and Education, Kelambakkam, Chengalpattu district, Tamil Nadu-603103, India.

*Patent officer, Department of Pharmacology Chettinad Hospital and Research Institute, Chettinad Academy of Research and Education, Kelambakkam, Chengalpattu district, Tamil Nadu-603103, India.

(Received: 07 January 2024 Revised: 12 February 2024 Accepted: 06 March 2024)

KEYWORDS

Indian Himalayas, antimicrobial agents, plant based phytochemical compounds, ethnomedicine, Himalayas.

ABSTRACT:

Introduction: The emergence of multidrug resistant bacteria has become a serious global concern. This is mainly because of the irrational use of antibiotics in both community and hospital settings which have led to the need for the development of new antimicrobials to combat the multidrug resistant bacteria. However, only limited antimicrobials are in the pipeline. This is mainly because of various scientific challenges, financial risks, many regulatory hurdles, and antibiotic stewardship. Also, the high toxic effect of the new drugs has necessitated effective antimicrobial agents with low toxicity. The Indian Himalayan region has a diverse range of plant species with extensive medicinal and antimicrobial property. In the recent years significant awareness has been gained due to the threat of multidrug resistant bacteria and the limited reserve drugs with higher toxicity. The phytochemical compounds from these Himalayan plants have gained attention in targeting the cellular activities and acts similarly as that of the antibiotics. The natural plant-based antimicrobials have shown promising results with a greater cost-effectiveness. This effort of discovering plant-based antimicrobials has brought out several novel plants from the Himalayan region. The current review will help to explore the efficacy of plants in the Himalayan region, its phytochemical constituents and scientific evidence supporting their antimicrobial property.

1. Introduction

In the era of antimicrobial resistance, the cascade of developing new antimicrobials has become difficult and rare, despite the immediate need for new antibiotics to combat the difficult to treat infections caused by the multidrug resistant organisms. This scenario has brought in the trend of discovering novel herbal plants which exhibits similar action as that of the antibiotics. Therefore, considering their antimicrobial properties the herbal extracts are a great option for treating the infections that could benefit the mankind. Also, further research on the newer antimicrobials from the natural plant sources can help to tackle infections caused by these multidrug resistant pathogens (1).

These herbal sources contain several bioactive compounds such as the alkaloid, flavonoids, lignans, glycosides, terpenes, lipids, and vitamins (2). Several phytochemical compounds have found to be greatly effective against several microbial pathogens and are used to treat several human infections. They are commonly used by Indian people and several herbal medicines have been recommended by WHO and are practised till date (3).

This review will add knowledge on several herbal plants which would help in exploring the antimicrobial

Journal of Chemical Health Risks

www.jchr.org

JCHR (2024) 14(2), 939-944 | ISSN:2251-6727

property of these plants which in turn can pave way for future drug discovery. These plants are known to produce phytochemicals structurally and functionally diverse and are active against microbes. Therefore, further research on these bioactive compounds can assist in the development of novel antimicrobials with limited toxicity (4). The Indian Himalayan region boasts unique ecological conditions and a rich biodiversity. This can be a promising source for many medicinal plants to develop novel antimicrobials. Many Himalayan medicinal plants have not been studied in detail. This review will focus on the systematic evaluation of several Himalayan medicinal plants and their antimicrobial properties underscoring the need for further research to harness their therapeutic benefits (5).

2. Methods

This methodical comprehensive review was conducted across various scientific databases including the PubMed, Scopus and Google scholar employing the keywords like "The Indian Himalayan plants", "antimicrobial properties" and phytochemical compounds. Research studies published from 2000 and 2023 were included in this review.

3. Phytogeography of Himalayas:

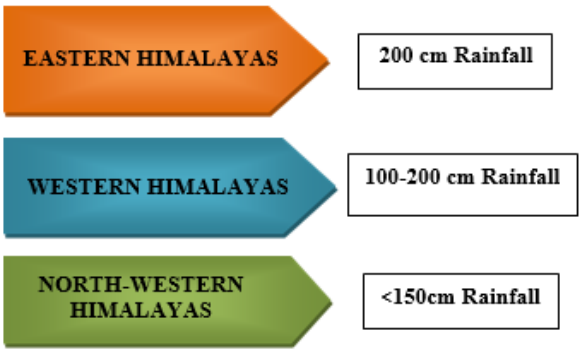
Globally, India is a biodiverse land, having 17,000 plant flora out of which 8000 are from the Himalayan region and 1748 (22%) are proposed to possess some medicinal property (6). When we investigate the global scenario, India has three major megadiverse hotspots among the total 34 hotspots worldwide. The three major megadiverse hotspots include the Western Ghats, Indo-Burma and the Himalayas. These hotspots have many endemic species with medicinal properties (7). The Himalayas is the greatest chain of mountains which runs in the length of about 2400 kms and the breadth is about 240-320km and total area of about 419871km^2. They are divided into three major regions such as Eastern Himalayas, Western Himalayas and North Western Himalayas based on their phytogeographic views. The vegetation zones of the Himalayan region include - tropical, sub-tropical and warm temperate zones which has subtropical broadleaf forests (Sal, hop-bush, wild olive), cool temperate zone consists of temperate broadleaf forests (oak, rhododendron, Himalayan maple). Sub-alpine zone has coniferous forests (east Himalayan fir, Sikkim larch, spruce, Himalayan Hemlock) and Alpine zone harbors shrublands and meadows (rhododendron, herbacous plants and alpine pasture land).

4. Phytogeographical distribution of the Himalayan region:

The eastern Himalayas accommodate Darjeeling, Sikkim, north Assam, and Arunachal Pradesh. The climate is very warm during the summer season and cool during the winter seasons; over 200 cm rainfalls is recorded. Common plants found in the eastern Himalayas especially in the sub-tropical pine forest, temperate wet ever-green forest and wet alpine forest are *Aquilaria malaccensis, Coptis teeta, Panax pseudoginseng* etc (8). The western Himalayas comprises of Jammu and Kashmir, Himachal Pradesh, Garhwal, Kumaon Himalayas. The climate is humid in summer and cold in the winter seasons and the rainfall is recorded around 100-200cms. Several medicinal plants commonly found are *Sarsurea costus, colchicum luteum, Atopa acuminate, Physochlaina praelta*. The north eastern Himalayas include Ladakh plateau and Gilgit district. The summer is mild and severe cold during the winter. The common plants found in the north-western Himalayas are *Achillea millefolium, Bunium persicum, picrorhiza kurroa, Jumiperus communis* and *Ephedra gerardiana*.

5. Schematic representation of the regional divisions in the Himalayas:

- Darjeeling, Sikkim, North Assam
- Arunachal Pradesh
- Warm summer, Cool winter
- Himachal Pradesh, Garhwal, Kumaon
- Warm humid summer, Cold
- Ladakh, Gilgit
- Mild summer, severe cold winter



Journal of Chemical Health Risks

www.jchr.org

JCHR (2024) 14(2), 939-944 | ISSN:2251-6727

6. Herbal importance of Himalayan region:

Few common herbs found in the Himalayan region: Table 1

There remains a tremendous scope in discovering novel medicinal compounds against many diseases and newer antimicrobial agents against multidrug resistant bacteria from this bio diverse Himalayan flora. Also, species in the Himalayan region offers greater possibilities of discovering new molecules that possess a good antimicrobial activity with minimal toxicity.

During the search of these novel compounds for drug discovery, it is advisable to look for the medicinal compounds in a selective region that holds better traditional knowledge, productivity and should integrate with the economical standards. The magnificent Himalayan Mountain range offer a wide array of medicinal compounds derived from the diverse plants. There exist several rare and unknown medicinal herbs that are yet to be discovered and evaluated for their medicinal properties as they remain in the dense mountain areas. Several studies have claimed that plant species growing in Kashmir Himalaya has been found effective against various respiratory diseases. Recent research studies on *Cimicifuga* and *Morus Alba* have reported that these species are found to be effective in treating SARS-CoV2 infection. However, the climatic changes in the Himalayan region have affected the cultivation of these medicinal herbs and their growth is found to be slow due to the adverse climatic conditions.

Table: 1 Highlights the list of herbs found in the Himalayan region.

S.NO	HERBS	ACTIVITY
1	Jatamansi	Anti-depressant, Anti-inflammatory, Anti-fungal, Anti-bacterial property
2	Himalayan Mandrake	Anticancer activity
3	Indian Ginseng	Infertility issues, insomnia, swellings, burns, insect bites
4	kutki	Antioxidant properties
5	Himalayan Barberry	Antibacterial properties
6	Himalayan Burdock	Anti-aging properties
7	Aconitum Ferox	Antidote, Anti-inflammatory property
8	Clematis Buchananiana	Inflammation, headache, indigestion, and toothache
9	West Indian Chickweed	Anti-inflammation
10	Rhus Semialata	Anti-Diarrheal property
11	Hemp Agrimony	Helps to treat throat infections
12	Valerian Jatamansi	Anti-depressant

7. Himalayan medicinal plants and their antimicrobial profile:

The plant species that exists in Himalayas range from 8,000 -10,000 among which 40% of them remain endemic. These plant taxa are believed to be diversified and evolved over millions of years following the Himalayan range formation. Due to the presence of alkaloid ephedrine compounds, Indian Himalayan plants are considered for its medicinal value and over 1749 species are reported to have medicinal properties out of 10,000 existing species (9).

In the Pakistan region of north-western Himalayas, plants such as *Berberis, Achillea miellefolium leaf, Berginaciliate and Abraun ex England aloe Vera* have been reported to possess antimicrobial properties against uropathogens such as *Escherichia coli and Staphylococcus species*. So far India has reported that over 17,000 species of plants among which 7,500 plant species have found to contain medicinal properties (10). In the Indian Himalayas, over 31% are considered as naive plants, 15% are endemic and 14% of them are threatened plants species (8). Among these many are considered to possess bioactive compounds. Some of the Himalayan herbs like *Prunes cornuta, Quereus semecarpifolia* have shown antibacterial activity against *Acinetobacter species, Salmonella species* and *E. coli* (11). The *Pinus roxburghini, Abies balsamea mill* and *Pinus brutia* has shown to have antimicrobial effect against *Methicillin Resistant Staphylococcus aureus* (MRSA). The *Dryopteris* has shown activity against *Pseudomonas aeruginosa* and the leaf extracts of *Equisteteum arvense* shows activity against

Journal of Chemical Health Risks

www.jchr.org

JCHR (2024) 14(2), 939-944 | ISSN:2251-6727

Escherichia coli, Klebsiella, Salmonella enterica, Aspergillus species and *Candida albicans*. (Table:2)
Though the bioactive compounds present in these plants have antimicrobial activity it is very important to standardize the compounds and proper quality control measures should be taken to ensure the safety and efficacy of these medicinal plants. The major challenges that emerge during the development of these novel herbal drugs with antimicrobial property include – optimization of the drug, determination of drug dosage and assessment of its toxicity.

8. Some of the plants in the Indian Himalayan region with antimicrobial activity.

Table-2 This table signifies the phytochemical compounds showing antimicrobial activity against several bacterial pathogens.

Plant	**Compounds**	**Organisms**	**Reference**
Abutilon theophrasti medik	Rutin, luteolin, tiliroside, poncirin	*Salmonella, E.coli*	[12]
Achyranthes aspera	Betaine, isobetanin, achyranthine	*E.coli, Pseudomonas spp,Bacillus spp.*	[13]
Allium sativum L.	Allicin,diallyl sulfide	*Burkholderia Cepacia, Helicobacter pylori*	[14]
Amaranthus scaudatus L.	Ferulic acid	*Escherichia coli*	[15]
Arnebiabenthamii	Shikonin	*Escherichia coli, Shigella, Salmonella, Klebsiella pneumoniae,*	[16]
Atropabella donna L.	Ethanolic extracts	*Staphylococcus aureus, Escherichia coli*	[17]
Berberis lyceum Royle	Berberine	*Streptococcus spp,Corynebacterium diphtheriae*	[18]
Brideliaretusa (L.) A. Juss.	Ethanolic extract	*Pseudomonas aeruginosa, Escherichia coli*	[19]
Calendula officinalis L.	Methanolic extract	*Serratia marcescens, Enterobacter cloacae, Alcaligenes*	[20]
Calotropis procera L.	α-Amyrin, lupeol acetate, gombasterol	*S.aureus, Klebsiella,E.coli*	[21]
Cannabis sativa L.	Cannabinoids	*Staphylococcus aureus (MDR, MRSA), Proteus mirabilis, Salmonella, Acinetobacter, Serratia marcescens*	[21]
Stramonium L.	Chloroform extracts	Staphylococcus aureus	[22]
Arota L.	Methylisoeugenol	*Campylobacter jejuni*	[22]
Dodecadenia grandflora N	GermacreneD, furanodiene	*Staphylococcus aureus, Pasteurella multocida*	[23]
Fritillaria roylei Hook	peonidin	*Escherichia coli, Klebsiella pneumoniae, Micrococcus*	[24]
Holarrhena antidysenterica Wall.	Conessine	*Acinetobacter baumannii, Pseudomonas aeruginosa*	[25]
Lindera pulcherrima Curzerenone	Furanodiene	*Staphylococcus aureus, Salmonella enterica*	[23]

Journal of Chemical Health Risks

www.jchr.org

JCHR (2024) 14(2), 939-944 | ISSN:2251-6727

Vitex negundo L.	Methanolic extract	*Vibrio cholerae, E. coli, Shigella*	[26]
Sonchus arvensis L.	Phenols and flavonoids	*Salmonella enterica, Vibrio parahaemolyticus, Staphylococcus aureus*	[26]

9. Future Prospects and Conclusion:

This review details the antimicrobial properties and various therapeutic potential of bioactive compounds present in various Indian Himalayan plants. This study also elaborates the information on Himalayan climate and vegetation which will help in search of novel medicinal plants. The compilation of several plants with antimicrobial activity will definitely help the future researchers to explore several novel plants and to characterize the bioactive compounds and to further elucidate their mechanism of action and to evaluate their efficacy and safety in preclinical and clinical settings. This contribution in the medical field would help to combat the emerging global threat of multidrug resistance.

10.Conflict of Interest:

Author has no conflict of interest in this article.

Reference:

[1] Benarba, B., & Pandiella, A. (2020). Medicinal plants as sources of active molecules against COVID-19. Frontiers in Pharmacology, 11,1189.https://doi.org/10.3389/fphar.2020.0118

[2] Mazurek, B., Chmiel, M., & Górecka, B. (2017). Fatty acids analysis using gas chromatography-mass spectrometer detector (GC/MSD)-method validation based on berry seed extract samples. Food Analytical Methods, 10,2868–2880. https://doi.org/10.1007/s12161-017-0834-1

[3] Ward, P. I. (2008). Environmental health perspectives. Journal of Cell Biology, 116, 15–30.

[4] Vaou, N., Stavropoulou, E., Voidarou, C., Tsakris, Z., Rozos, G., Tsigalou, C., & Bezirtzoglou, E. (2022). Interactions between medical plant-derived bioactive compounds: Focus on antimicrobial combination effects. Antibiotics,11,1014. https://doi.org/10.3390/antibiotics11091014

[5] Bhat, M. N., Singh, B., Surmal, O., Singh, B., Shivgotra, V., & Musarella, C. M. (2021). Ethnobotany of the Himalayas: Safeguarding medical practices and traditional uses of Kashmir regions. Biology, 10, 851. https://doi.org/10.3390/biology100908516.

[6] Singh, D. K., & Pusalkar, P. K. (2020). Floristic diversity of the Indian Himalaya. In G. H. Dar & A. A. Khuroo (Eds.), Biodiversity of the Himalaya: Jammu and Kashmir State (Vol. 18, pp. 93–126). Springer.

[7] Chhetri, D. R. (2015). Medicinal Plants of the Himalaya: Production Technology and Utilization (1st ed.). Agrobios.

[8] Samant, S. S., & Pant, S. (2006). Diversity, distribution pattern and conservation status of the plants used in liver diseases/ailments in Indian Himalayan region. Journal of Mountain Science,3,28–47. https://doi.org/10.1007/s11629-006-0028-

[9] Shiva, M. P. (1998). Inventory of Forest Resources for Sustainable Management & Biodiversity Conservation with Lists of Multipurpose Tree Species Yielding Both Timber & Non-Timber Forest Products (Ntfps), and Shrub & Herb Species of Ntfp Importance (1st ed.). Indus Publishing Company.

[10] Ghimire, S. K., Sapkota, I. B., Oli, B. R., & Parajuli, R. R. (2008). Non-timber forest products of Nepal Himalaya: database of some important species found in the mountain protected areas and surrounding regions. WWF Nepal.

[11] Tian, C.; Zhang, P.; Yang, C.; Gao, X.; Wang, H.; Guo, Y.; Liu, M. Extraction process, component analysis, and in vitro antioxidant, antibacterial, and anti-inflammatory activities of total flavonoid extracts from Abutilon Theophrasti Medic. Leaves. Mediat. Inflamm. 2018, 2018, 3508506.

[12] Mishra, D. Antibacterial activity of alkaloids present in plant Achyranthes aspera. Pharma Innov. J. 2018, 7, 147–153.

[13] Kyung, K.H. Antimicrobial properties of Allium species. Curr. Opin. Biotechnol. 2012, 23, 142–147.

Journal of Chemical Health Risks

www.jchr.org

JCHR (2024) 14(2), 939-944 | ISSN:2251-6727

[14] .Borges, A.; Ferreira, C.; Saavedra, M.J.; Simões, M. Antibacterial activity and mode of action of ferulic and gallic acids against pathogenic bacteria. Microb. Drug Resist. 2013, 19, 256–265.

[15] Shameem, N.; Kamili, A.N.; Parray, J.A.; Hamid, R.; Bandh, S.A. Antimicrobial and antioxidant activity of methanol extracts of Arnebia benthamii (Wall Ex. G. Don) Johnston—A critically endangered medicinal plant of North Western Himalaya. J. Anal. Sci. Technol. 2015, 6, 36.

[16] Munir, N.; Iqbal, A.; Altaf, I.; Bashir, R.; Sharif, N.; Saleem, F.; Naz, S. Evaluation of antioxidant and antimicrobial potential of two endangered plant species Atropa belladonna & Matricaria chamomilla. Afr. J. Tradit. Complement. Altern. Med. 2014, 11, 111.

[17] Owk, A.K.; Lagudu, M.N. Bridelia retusa (L.) Spreng. Fruits: Antimicrobial efficiency and their phytochemical constituents. Not. Sci. Biol. 2016, 8, 33–36.

[18] Hernández-Díaz, J.A.; Garza-García, J.J.; León-Morales, J.M.; Zamudio-Ojeda, A.; Arratia-Quijada, J.; Velázquez-Juárez, G.; López-Velázquez, J.C.; García-Morales, S. Antibacterial activity of biosynthesized selenium nanoparticles using extracts of Calendula officinalis against potentially clinical bacterial strains. Molecules 2021, 26, 5929.

[19] Blaskovich, M.A.T.; Kavanagh, A.M.; Elliott, A.G.; Zhang, B.; Ramu, S.; Amado, M.; Lowe, G.J.; Hinton, A.O.; Pham, D.M.T.; Zuegg, J.; et al. The Antimicrobial potential of Cannabidiol. Commun Biol 2021, 4, 7.

[20] Solomon, B.; Nega, B.; Wagaw, S.; Lianzhong, A. Antibacterial activity of Datura stramonium against standard and clinical isolate pathogenic microorganisms. J. Med. Plants Res. 2017, 11, 501–506.

[21] Dedieu, L.; Brunel, J.M.; Lorenzi, V.; Muselli, A.; Berti, L.; Bolla, J.M. Antibacterial mode of action of the Daucus carota essential oil active compounds against Campylobacter jejuni and efflux-mediated drug resistance in gram-negative bacteria. Molecules 2020, 25, 5448.

[22] Joshi, S.C.; Verma, A.R.; Mathela, C.S. Antioxidant and antibacterial activities of the leaf essential oils of Himalayan Lauraceae species. Food Chem. Toxicol. 2010, 48, 37–40.

[23] Bhat, B.A.; Mir, W.R.; Sheikh, B.A.; Rather, M.A.; Dar Tul, H.; Mir, M.A. In Vitro and in silico evaluation of antimicrobial properties of Delphinium cashmerianum L., a medicinal herb growing in Kashmir, India. J. Ethnopharmacol. 2022, 291, 115046.

[24] Siriyong, T.; Chusri, S.; Srimanote, P.; Tipmanee, V.; Voravuthikunchai, S.P. Holarrhena Antidysenterica extract and its steroidal alkaloid, Conessine, as resistance-modifying agents against extensively drug-resistant Acinetobacter baumannii. Microb. Drug Resist. 2016, 22, 273–282.

[25] Kamruzzaman, M.; Bari, S.M.N.; Faruque, S.M. In vitro and in vivo bactericidal activity of Vitex negundo leaf extract against diverse multidrug resistant enteric bacterial pathogens. Asian Pac. J. Trop. Med. 2013, 6, 352–359.

[26] Xia, D.Z.; Yu, X.F.; Zhu, Z.Y.; Zou, Z.D. Antioxidant, and antibacterial activity of six edible wild plants (Sonchus sp.) in China. Nat. Prod. Res. 2011, 25, 1893–1901.