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Research Article

AN ETHNOPHARMACOLOGICAL REVIEW OF THREE NOTABLE MEDICINAL PLANTS FOUND IN THE UNION TERRITORY OF LADAKH, INDIA

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ABSTRACT: The paper deals with the thorough review of ethnopharmacological knowledge of three medicinal plants *(Mentha longifolia, Peganum harmala, and Podophyllum hexandrum)* of Union Territory of Ladakh, India, their traditional practices by the inhabitants of the area for their daily sustenance. Traditional medicine of the cold desert of Ladakh has immense potential to treat various ailments among tribal communities inhabiting the remotest region of the Indian subcontinent. The documentation and review of ethnopharmacological information, phytochemical and pharmacological validation, and their traditional use in different remedies and to conserve the disappearing traditional knowledge system of Ladakh, India, the plants mentioned above have been studied in detail in the present paper.

Key words: : Traditional knowledge, Noteworthy medicinal plants of Ladakh, Trans-Himalaya, Indian Himalayan region.

INTRODUCTION

The ethnic and rural people are accustomed to the use of various parts of different plants to prevent or cure many of their ailments and many of these plants are found effective after analyzing them with the use of modern research tools (Pattanayak 2021, Pradhan *et al.* 2022, Paul and Sujatha 2022). The present study was performed in a remote cold desert area of India, Ladakh.

Ladakh is the largest, northernmost, loftiest, and remotest union territory in the Indian Republic. It is a cold desert that lies between 32.5º-37.20ºN and 72.30º-80.15ºE and covers approximately 82,665 km^2 (Shukla and Srivastava 2020). It is also one of the most elevated inhabited regions of the earth, ranging from 2900 m to 5900 m. Despite its size, it is sparsely populated, with only 3-5 persons per km^2. The region is a mountainous terrain with altitudes ranging from 4500-7000 m, attracting mountaineers from all over the world. The soil of the region is mainly sandy or sandy loam, with appreciable quantities of clay at some places, and the pH ranges between 7-11 (Bhat 1965). Ladakh, a region situated in the northernmost part of India, is well-known for its remarkable biodiversity. It is home to various species of fauna, including the elusive snow leopard, the charming Himalayan marmot, and the majestic black naked crane, among others. Overall, Ladakh's rich ecological landscape is a testament to the region's unique and remarkable natural heritage.

Ethnopharmacology is a highly specialized field of research that involves the observation, identification, description, and experimental investigation of the components and effects of traditional medicines. This interdisciplinary area of study is crucial for understanding and preserving the knowledge of indigenous drugs used in traditional medicine (Ghorbani *et al.* 2006). Although medicinal plants have been used for centuries to treat various diseases, this knowledge is continuously eroding despite its immense importance to humanity (Ojha *et al.* 2020). Therefore, documenting the traditional knowledge of local communities regarding the use of medicinal plants in regions such as Ladakh is of great significance.

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MATERIALS AND METHODS

The study was conducted to document the traditional knowledge of local communities in the Ladakh region regarding the use of medicinal plants. It involved literature reviews, fieldwork, and interviews with local healers and experts in traditional medicine. The study was carried out between April to December 2022.

The authors identified and documented three notable medicinal plant species used by the local communities for various health conditions. The documented species were identified and authenticated by consulting various floras and revisions (Kachroo *et al.* 1977, Srivastava and Shukla 2014) and cross-checked with herbarium specimens. Most of the ethnobotanical information has been taken from the published literature (Chaurasia *et al.* 2008, Mikaili *et al.* 2013, Mokaberinejad *et al.* 2014) and some are recorded new from ethnic groups, local healers, Akhons, Abas, and Amchies.

RESULTS AND DISCUSSION

The study report is shown in Table 1. Details of the plant and previous reports related to the use of the plants as well as the identified phytochemicals are also displayed in the table.

Table 1. Information related with the three notable medicinal plants used in the cold desert area of Ladakh, India.

Plant	Reported use	Phyto-chemicals identified	Present finding
Mentha longifolia L. Family: Lamiaceae Vernacular names: Jangali Pudina (Hindi), Foololing (Ladakhi)	Antibacterial, digestive, stimulant, and antispasmodic agents to treat various ailments, headaches, and indigestion (Naghibi *et al.* 2005, Mikaili *et al.* 2013); colic, menstrual cramps, indigestion, bloating, pulmonary infections and congestion, headaches, fevers, coughs, colds, gallbladder, skin and respiratory tract infections, headaches, urinary tract infections (Mimica-Dukic and Bozin 2008); to treat phlegm disease, cancer, swelling, and indigestion (Angmo *et al.* 2019); having immunomodulation activities (Pattanayak 2020); can reduce FSH and improve amenorrhea (Mokaberinejad *et al.* 2014). Essential oils and seed extracts have antibacterial, bactericidal, antiviral, insecticidal, and antioxidant properties (Brahmi *et al.* 2017).	Flavonoids, phenolic acids (caffeic acid derivatives), essential oil-based monoterpene ketones (Hajlaoui *et al.* 2009, Iqbal *et al.* 2013, Llórens-Molina *et al.* 2015) and eucalyptol (Murad *et al.* 2016). Gas chromatography and mass spectrometry analysis have shown that the main compounds within the essential oil of this plant are: Menthol (19.4-32.5%), menthone (20.7-28.8%), pulegone (7.8-17.8%), 1,8-cineole (5.6-10.8%), which play an important role in the various effects (Hajlaoui *et al.* 2008).	Used in urinary disorders, stomach aches, for aiding digestion, to purify blood. Three to four leaves are boiled in one glass of water and allowed to cool. Two to three fresh leaves of the same species are then added to the water before consumption.
Peganum harmala L. Family: Zygophyllaceae Vernacular name: Harmal (English, Hindi)	Seed decoctions for symptoms related to psychosis, kidney stones, rheumatism, jaundice, sciatica, and sexual impotence, and powders and smokes for asthma, boils, pimples, and digestive issues (Elansary *et al.* 2020), are also used to treat diabetes (Bnouham *et al.* 2002), as an analgesic for heart disease (Abbas *et al.* 2021, Diba *et al.*	The present secondary metabolites consist of more than 390 compounds including alkaloids, flavonoids, triterpenoids, phenolic acids, anthraquinones, fatty acids, and essential oils. Its primary secondary metabolite is â-carboline alkaloids (Li *et al.* 2018). Harmine, harmaline, and vasicine are representative compounds that exhibit various pharmacological	The plants are burned and the smoke is allowed to go in the nose to stop bleeding.

Plant	Reported use	Phyto-chemicals identified	Present finding
	2011), seeds and aerial parts are also used as anti-inflammatory agents (Bensalem *et al.* 2014), in traditional Chinese medicine, the seeds are used in cancer, cough, diabetes, asthma, rheumatism, jaundice, hypertension, colic, and back pain (Wu *et al.* 2020); also to treat amnesia (Deng *et al.* 2019), to treat hypertension and cardiac disease (Tahraoui *et al.* 2007, Moradi *et al.* 2017), Parkinson's disease, in psychiatric conditions (Herraiz *et al.* 2018), colic in man and animals (Mirzaie *et al.* 2007). The plant has antimicrobial, anti-inflammatory, analgesic, and anti-tumor properties (Hosseinzadeh *et al.* 2015); seeds are also used to treat fever, malaria, hysteria, neuralgia, rheumatism, asthma, syphilis, and eye infections (Monsef *et al.* 2004, Farouk *et al.* 2008).	actions (Di Giorgio *et al.* 2004). It also contains significant amounts of essential oils with alcanfor, capillin, eugenol, α-pinene, monoterpene hydrocarbons, and propylic acid being the main components (Dastagir *et al.* 2014, Tahrouch *et al.* 1998).	
Podophyllum hexandrum Royle, Family: Berberidaceae Vernacular name: Mayapple (English); Danmokusho (Ladakhi)	It is used in renal and urinary disorders, the rhizome and fruits are used to cure various gynecological problems and menstrual conditions (Ballabh and Chaurasia 2007); the whole plant is used in constipation, colds, fever, septic wounds, burns, insect bites, psychiatric disorders, rheumatism, and plague; in allergic and inflammatory diseases (Ballabh *et al.* 2008); in skin diseases (Ballabh *et al.* 2008). A paste of the rhizomes and roots taken orally to relieve diarrhea, gastritis, cholera, ulcers, and indigestion (Kala *et al.* 2004); rhizome powder as anthelmintic (Li *et al.* 2009); used in diseases like Wilm's tumors, genital tumors, 'molluscum contagiosum', psoriasis vulgaris, non-Hodgkin lymphoma and other lymphomas, cancer of brain, lung, bladder, leukemia (Beutner and Krogh 1990). A paste of rhizomes and roots can also be taken orally to relieve diarrhea, gastritis, cholera, ulcers, and indigestion (Kala *et al.* 2004).	The root contains several important anti-cancer lignans, including podophyllin and berberine, and is also anti-rheumatic (Chaurasia *et al.* 2012), the young, ripe fruits are edible and help prevent altitude sickness (Angmo *et al.* 2019). It contains podophyllin, podophyllotoxin, quercetin, 4-demethylpodophyllotoxin, podophyllotoxinglucoside, 4 dimethyl podophyllotoxinglucoside, kaempferol, icropodophylotoxin, deoxypodophyllotoxin, picropodophylotoxin, isopicropodophyllone, 4 Methyl deoxy-podophyllo toxin, peltatin, and Speltatin. The roots and rhizomes are known to synthesize much of secondary metabolites, besides podophyllotoxin and multifaceted pharmacological applications (Kalam *et al.* 2021, Anand *et al.* 2022).	The whole plant is used for gynecological diseases (menstrual irregularity, uterus pain and baby delivery problems) and improving lung and blood circulation. Besides, the fruit is useful against high altitude mountain sickness.

Fig. 1. (From top to bottom) ***Mentha longifolia*** **(L.),** ***Peganum harmala*** **L.,** ***Podophyllum hexandrum*** **Royle.**

CONCLUSION

Mentha longifolia, Peganum harmala and *Podophyllum hexandrum* have been extensively studied for their potential therapeutic properties in traditional medicine. These plants contain various bioactive compounds such as essential oils, alkaloids, flavonoids, and terpenes, which have shown promising pharmacological activities, including antimicrobial, anti-inflammatory, analgesic, antitumor, and antidiabetic effects. Despite the promising therapeutic potential of these plants, more research is required to fully understand their pharmacological mechanisms and safety profiles. Furthermore, it is important to conduct clinical trials to determine the efficacy and safety of these plants in humans. This will help to validate their traditional uses and pave the way for their integration into modern medicine.

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