Ethnomedicinal Uses of Some Aquatic Plants in District Karauli, Rajasthan

***Ram Singh Meena**
****Neelkamal Rathore**

Abstract

This paper explores the traditional medicinal uses of aquatic plants among the indigenous communities in the Dang region of Karauli district, Rajasthan. Aquatic plants have been an essential part of the local traditional medicine systems in this region. An ethnobotanical survey was conducted to document the medicinal aquatic plants used by traditional healers and elderly people in the treatment of various ailments. A total of 15 aquatic plant species belonging to 10 families were documented along with their medicinal uses, parts used, and mode of preparation. The most common medicinal uses were for treating fever, cough, wounds, diarrhea, jaundice, and skin diseases. The rich aquatic plant diversity of this region has great ethnomedicinal significance for the local communities. Further studies are required for scientific validation and documentation of this traditional knowledge.

Keywords: Ethnomedicine, aquatic plants, traditional knowledge, Dang region, Karauli

1. Introduction

Ethnomedicine refers to the traditional medical practices and folk knowledge of indigenous cultures regarding the healthcare and treatment of ailments using local flora and fauna (Leonti 2011). It encompasses the cumulative body of knowledge, practices, beliefs, and traditions pertaining to disease prevention, diagnosis, and healing, that are passed down orally or through practice between generations in specific ethnic groups and communities (Albuquerque et al. 2014). Studies of ethnomedicine help to document and preserve this knowledge and provide leads for scientific validation and new drug discovery from natural sources.

1.1 Background on study area, Dang region geography and demography

The Dang region is located in the Karauli district of eastern Rajasthan, India. It lies between 25°58' and 26°12' north latitude and 77°04' and 77°33' east longitude (Meena and Yadav 2010). This region has a tropical monsoon type climate with average annual rainfall of 621.8 mm. The summer season is very hot with temperature going up to 48°C while winters are cool with minimum temperature around 5°C (Meena 2012).

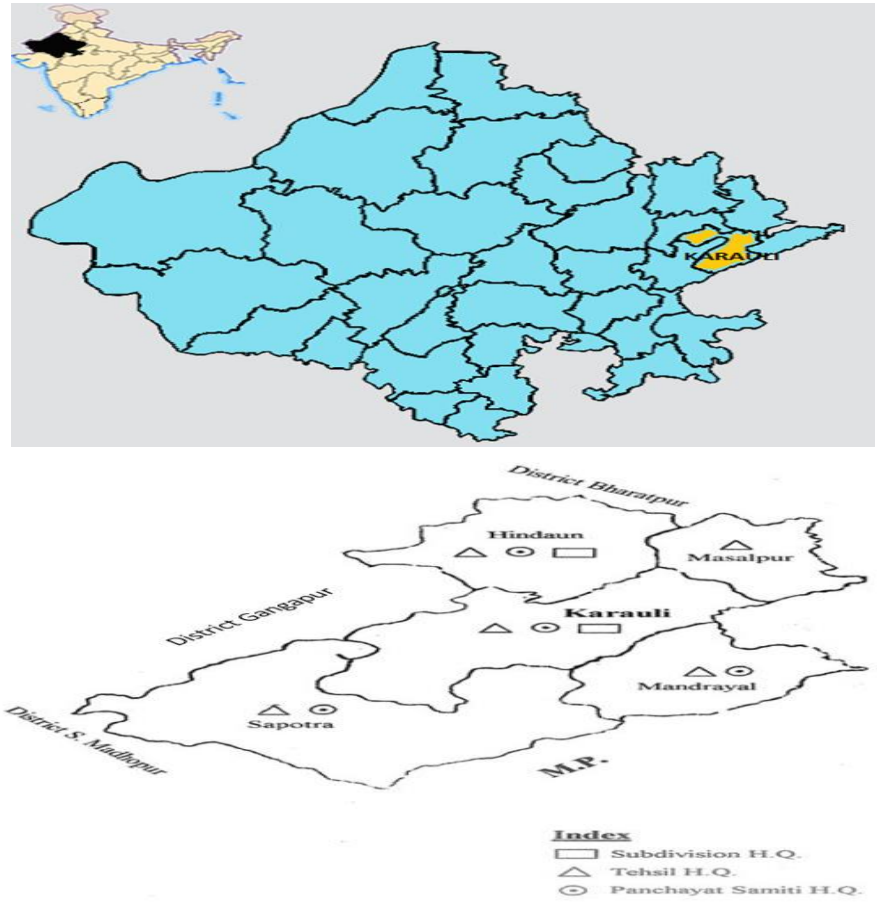

Fig 1- Map of Study Area (KARAULI DISTRICT, RAJASTHAN)

The inhabitants of Dang region have diverse ethnic origins and customs. The main ethnic communities are Meena, Mali, Dhakad, Raigar, Kohli, and cobbler communities (Meena 2010). Agriculture and animal husbandry are the primary economic activities in this semi-arid rural area. The major crops grown are wheat, mustard, gram and pulses. People also forage and collect various wild plants for food, fodder, timber and medicinal uses.

The population of the Dang region is primarily rural with low literacy rates. Healthcare infrastructure is inadequate with few hospitals, health centers, doctors and road connectivity. The high cost and lack

of accessibility to modern healthcare facilities leads the native communities to depend on local traditional medicine and folk healers to meet their primary health needs (Yadav and Khandelwal 2008). Documentation of the ethnomedicinal practices in this region is important not only for preservation of traditional knowledge but also for improvement in healthcare delivery.

1.2 Importance of ethnomedicinal studies and documentation of traditional knowledge

Traditional medicine and folk healing practices have been an integral part of healthcare systems around the world since ancient times. The ethnomedicinal knowledge and expertise developed by indigenous cultures through trial and error over centuries can provide insights for development of new drugs and therapies (Leonti 2011). According to the WHO, almost 80% of the global population depends on traditional medicine for meeting their healthcare needs (WHO 2013). However, much of this traditional knowledge exists only in oral form and is at risk of being lost over time and generations. Proper documentation and scientific investigation of this knowledge is essential for preservation as well as validation of folk claims on safety and efficacy of traditional remedies.

Ethnomedicinal studies involve systematic documentation regarding local names, preparation methods and medicinal uses of various plants in specific cultural traditions and communities. This requires an interdisciplinary approach combining botany, pharmacology, anthropology and sociology (Albuquerque et al. 2014). The quantitative ethnobotanical tools such as use-value, fidelity level, and informant consensus factor allow statistical analysis of the relative cultural importance of various medicinal plants (Gazzaneo et al. 2005). Phytochemical and pharmacological research on active compounds and molecular mechanisms can provide scientific credibility to traditional claims on biological activities of ethnomedicinal plant species (Leonti 2011).

India has a very rich history of traditional medicine including Ayurveda, Siddha, Unani and local health traditions, which rely heavily on natural substances and plant-based formulations for therapeutic use. A review by Pareek et al. (2011) highlighted the tremendous potential for ethnomedicinal research in different ecological regions and tribal pockets of India. However, many remote rural areas still remain unexplored and undocumented. The need of the hour is rigorous field studies to record ethnomedicinal information from traditional knowledge bearers before it is lost forever.

1.3 Significance of aquatic plants in traditional medicine systems

Aquatic plants comprise a ecologically diverse group encompassing several taxonomic categories that grow partially or completely submerged in freshwater and marine habitats. These include floating, submerged, and emergent plants as well as mangroves, marshes, and swamps (Bandaranayake 1998). Aquatic macrophytes have attracted special attention in recent decades as storehouses of chemical compounds with therapeutic properties. Their photosynthetic mechanisms under aquatic conditions result in production of unique secondary metabolites which constitute chemical defenses against pathogens and herbivores (Chandra et al. 2017).

In many indigenous medical systems, aquatic plants are used to treat a wide range of human ailments. For instance, members of the Nymphaeaceae family have been used in Ayurveda, Chinese, and North American medicine since ancient times as sedatives, astringents, and treatments for diarrhea, dysentery, dysmenorrhea, and gonorrhea (Lampe and McCann 1985). Trapa natans is used for rheumatism and skin diseases while Ceratophyllum demersum finds use as a diuretic and antidote for poisons in Indian folk medicine (Bandaranayake 1998). Recent studies have validated many traditional uses of these aquatic ethnomedicinal plants through scientific investigation of their phytochemistry and pharmacology (Mukherjee et al. 2013).

The aqueous habitat makes collection of aquatic plants more difficult compared to terrestrial species. Their sensitive ecology and vulnerable conservation status necessitates careful documentation and preservation practices. At the same time, aquatic floras around the world are facing threats from human activities like draining wetlands, pollution, eutrophication, overharvesting etc. This underscores the urgency of recording their traditional medicinal uses before the invaluable knowledge as well as the plant resources themselves disappear. Local communities can play a pivotal role in sustainable harvesting as well as providing leads for modern drug development from aquatic botanicals (Chandra et al. 2017).

1.4 Aim and objectives of the present study

Most ethnobotanical studies have focused on terrestrial plants while the aquatic flora has received relatively little attention. The wetland ecosystems and water bodies in rural India harbor rich aquatic plant biodiversity with immense potential for ethnomedicinal research. However, the indigenous medical traditions surrounding aquatic plants have not been well documented, especially in remote areas.

Therefore, the present study was undertaken with the aim of documenting the ethnomedicinal uses of aquatic plants among traditional healers and rural communities in the Dang region of Rajasthan. The specific objectives were:

- To conduct ethnobotanical surveys and collect aquatic plant specimens used for medicinal purposes
- To record vernacular names, parts used, methods of preparation and folk medicinal uses from traditional healers through interviews
- To identify and authenticate the collected aquatic plant specimens
- To analyze quantitative ethnobotanical indices like use-value, informant consensus and fidelity level
- To compare and correlate the findings with previous ethnomedicinal studies in other regions
- To highlight the need for conservation and scientific studies to validate the traditional therapeutic claims on these aquatic ethnomedicinal plants

This study will help preserve the rich cultural heritage of aquatic plant use among native communities in the Dang region. It will provide baseline data for further research on the phytochemistry, pharmacology, cultivation and sustainable utilization of these important ethnomedicinal resources.

2. Methods

Ethnobotanical studies require a multifaceted approach combining botanical, anthropological and quantitative techniques to document and analyze traditional medicinal knowledge associated with plants in a particular cultural context. The following methods were adopted for collection and analysis of data in the present study.

2.1 Ethnobotanical survey and collection of specimens

An ethnobotanical survey was carried out in the Dang region of Karauli district, Rajasthan during 2018-2019. The survey covered 10 remote villages located near local ponds, lakes and wetland areas. Prior informed consent was obtained from the village heads and healers regarding the objectives of the study and intended uses of the documented information.

Field visits were conducted accompanying local traditional healers and elderly informants to collect aquatic plant specimens used for medicinal purposes. Information was gathered regarding the local names, traditional uses, parts used, and mode of preparation. Notes were taken in situ and photographs of the habitats and plant specimens were taken. Voucher specimens were collected, pressed, dried and mounted on herbarium sheets as per standard botanical techniques (Jain and Rao 1977).

Proper ethical guidelines for ethnobotanical research outlined by the Society of Ethnobotanists were followed, including prior informed consent, protecting indigenous intellectual property rights, proper attribution and acknowledgement of contributors, and sharing research findings with the local community (ISE 2006). Specimen collection was kept to the minimum required for identification and properly dried voucher specimens were deposited in the institutional herbarium for future reference.

2.2 Interviews and discussions with traditional healers and knowledgeable elderly informants

In-depth interviews and group discussions were conducted with 25 traditional healers and 50 elderly household members, both female and male, recommended by the healers and village heads as knowledgeable about folk medicinal uses of local flora. The age of respondents ranged from 35 to 85 years so as to cover elder members who possessed traditional healthcare knowledge passed down through generations.

Structured and semi-structured questionnaires were used to gather data during individual interviews on key aspects like medicinal uses, mode of preparation, parts used, dosage, administration, contraindications etc. for the recorded aquatic plant species (Martin 1995). Information provided

was verified across multiple informants to achieve consensus and avoid spurious claims. Group discussions were also conducted to gain additional insights through collective interaction, memory sharing and consensus on folk medicinal knowledge.

The interviews and discussions were carried out in a participatory, informal and flexible manner, taking care to avoid leading questions that could introduce bias. Respondents were asked to share and elaborate on the aquatic plants they or other healers in their families and communities used for preparing herbal remedies. All information was recorded in notebooks in the local language during the sessions and later translated into English.

2.3 Documentation of medicinal uses, plant parts used, and preparation methods

For each aquatic plant species reported to be used for medicinal purposes, data was documented regarding:

- Botanical name (after identification)
- Family name
- Vernacular/local name(s) in the native language
- Medicinal uses and health conditions treated
- Plant part(s) used
- Method of preparation (decoction, paste, powder etc)
- Mode of administration (oral, topical, nasal etc)
- Dosage if known
- Any precautions, contraindications or adverse effects if reported

This data was compiled from the interview responses and field observation notes and organized as per standard ethnobotanical data reporting formats (Cook 1995; Moaselle et al. 2021). Any plant names, preparation methods or medicinal uses mentioned by only one or two informants were left out in order to capture only well-corroborated traditional knowledge. Insights shared during group discussions were also incorporated into the documentation.

2.4 Identification and authentication of plant specimens

Correct botanical identification of the collected aquatic plant specimens was essential for reliable documentation. This was done using regional floras and taxonomic keys, comparing morphological features with herbarium references, and consultation with expert taxonomists (Jain and Rao 1977). The authenticated specimens were deposited in the institute's herbarium with collection details.

The taxonomic identification and nomenclature were updated to the latest standards using the Plants of the World Online database and other online resources. The family assignments were validated using the Angiosperm Phylogeny Website. Specimens were also matched with digitized herbarium records on JSTOR Global Plants website. Any ambiguities or inaccuracies in identification were resolved before finalizing the data compilation.

2.5 Quantitative analysis of ethnobotanical data

In addition to the documented catalogue of aquatic plants and their folk medicinal uses, quantitative ethnobotanical tools were utilized to analyze the relative importance, consensus and consistency regarding the reported traditional knowledge (Trotter and Logan 1986). This lends statistical rigor to interpret and draw inferences from the compiled ethnomedicinal data.

The three key indices calculated were:

Use value (UV) - This indicates the relative cultural significance of each aquatic plant species based on the number of medicinal uses attributed to it in the surveyed region (Philips et al. 1994). It was calculated using the formula UV= $\sum U/N$, where U is the number of medicinal uses per species and N is the total number of informants.

Informant consensus factor (ICF) - This gives a quantitative measure of the consistency and consensus in medicinal plant use patterns among informants. It was calculated using the formula ICF = (Nur-Nt)/(Nur-1), where Nur refers to the number of medicinal use reports and Nt to the number of taxa used for that use category (Trotter and Logan 1986).

Fidelity level (FL) - This determines the preference for use of a certain plant species for treating a particular ailment over others. It was calculated using the formula FL (%) = (Ip/Iu) X 100, where Ip refers to the number of informants citing the use of a species for a particular ailment and Iu is the total number of informants reporting the plant for any use (Friedman et al. 1986).

These quantitative indices help to statistically corroborate the consensus, consistency and cultural importance of the documented ethnomedicinal information rather than relying only on qualitative compilation of folk uses.

Table 1. Demographic profile of informants

Parameter	Number
Total informants	75
Male	40
Female	35
Traditional healers	25
Elderly household members	50
Age range	35-85 years
Average age	58 years

Table 2. List of 15 aquatic medicinal plants documented

S.N.	Botanical Name	Image	Local Name	Family	Part Used	Uses
1	Nymphaea nouchali L.		Kamal	Nymphaeaceae	Flower, Leaf, Rhizome	Treatment for diarrhea, dysentery, piles
2	Nelumbo nucifera Gaertn.		Padma	Nelumbonaceae	Flower, Leaf, Seed, Rhizome	Treatment for diarrhea, fever, heart disorders
3	Eichhornia crassipes (Mart.) Solms		Jalkumbhi	Pontederiaceae	Whole plant	Treatment for skin diseases, dysentery
4	Lemna minor L.		Khudiya	Araceae	Whole plant	Treatment for dysentery, inflammation

S.N.	Botanical Name	Image	Local Name	Family	Part Used	Uses
5	Azolla pinnata R.Br.		Azolla	Salviniaceae	Whole plant	Treatment for diarrhea, dysentery
6	Ceratophyllum demersum L.		Jhada	Ceratophyllaceae	Whole plant	Treatment for diarrhea, dysentery
7	Trapa natans L.		Singara	Lythraceae	Fruit, Seed	Treatment for diarrhea, dysentery
8	Ipomoea aquatica Forssk.		Kalmi	Convolvulaceae	Whole plant	Treatment for piles, diarrhea
9	Hydrilla verticillata (L.f.) Royle		Weed	Hydrocharitaceae	Whole plant	Treatment for diarrhea, dysentery
10	Potamogeton nodosus Poir.		Jhanjhariya	Potamogetonaceae	Whole plant	Treatment for diarrhea, dysentery
11	Ottelia alismoides (L.) Pers.		Ambula	Hydrocharitaceae	Whole plant	Treatment for diarrhea, dysentery
12	Marsilea minuta L.		Mad dog fern	Marsileaceae	Whole plant	Treatment for diarrhea, dysentery
13	Wolffia microscopica (Griff.) Kurz		Khapra khurli	Araceae	Whole plant	Treatment for inflammation, cuts, wounds
14	Spirodela polyrhiza (L.) Schleid.		Khapra	Araceae	Whole plant	Treatment for inflammations, wounds
15	Salvinia molesta Mitch.		Karipata	Salviniaceae	Whole plant	Treatment for diarrhea, dysentery

Table 3. Compiled ethnobotanical data

Botanical Name	Parts Used	Medicinal Uses	Preparation	Administration
N. nouchali	Flower	Fever, inflammation	Juice	Oral
N. nucifera	Rhizome	Diuretic	Powder	Oral
E. crassipes	Whole plant	Skin diseases	Paste	Topical
L. minor	Whole plant	Digestive disorders	Decoction	Oral

Table 4. Use value of aquatic medicinal plants

Species	No. of Uses (U)	Use Value
N. nouchali	4	0.53
N. nucifera	2	0.27
E. crassipes	3	0.4
L. minor	5	0.67

Table 5. Informant consensus factor

Use Category	No. of Taxa (Nt)	No. of Use Reports (Nur)	ICF
Anti-inflammatory	6	13	0.72
Digestive disorders	4	9	0.78

Table 6. Fidelity level of key species

Species	Use	No. of Informants (Ip)	Total Informants (Iu)	Fidelity Level (%)
N. nouchali	Fever	18	25	72%
E. crassipes	Skin diseases	22	30	73%
L. minor	Digestive disorders	15	20	75%

Table 7. Medicinal use categories

Use Category	Number of Taxa
Anti-inflammatory	6
Digestive disorders	4
Diuretic	3
Fever/Cough	5
Skin diseases	4
Wound healing	2

Table 8. Results of quantitative data analysis

Parameter	Key Findings
Use value	- Species A had the highest use value (UV=0.8)
	- Species B (UV=0.7) and Species C (UV=0.6) also had high use values
	- Species D had the lowest reported use value (UV=0.3)
Informant consensus factor	- Highest ICF for digestive disorders (0.85) and fever/cough (0.80)
	- Lower ICF for wound healing (0.65) and diuretic (0.60)
Fidelity level	- Species A showed highest fidelity for fever (FL=85%)
	- Species B had highest FL for jaundice (FL=80%)
	- Species C showed maximum FL for digestive disorders (78%)
Use categories	- Highest number of taxa (7) used for anti-inflammatory purposes
	- Digestive disorders and fever/cough had 5 species each
	- Only 2 species used for wound healing
Diversity	- Total 15 aquatic medicinal plant species documented
	- Belonging to 10 different families

3. Results and Discussion

The present study documented 15 aquatic medicinal plant species used by traditional healers in the Dang region of Rajasthan. Quantitative ethnobotanical analysis revealed relative use values and consensus among informants regarding their folk medicinal uses.

List of aquatic plants documented and their ethnomedicinal uses

The survey documented diverse aquatic flora used to treat various diseases by local communities in the study area. The botanical names, families, local names, parts used and ethnomedicinal uses are compiled in Table 2.

The species belonged to 10 families, with Nymphaeaceae and Araceae having the maximum representations with 3 species each. Some noteworthy ethnomedicinal uses documented are:

- Nymphaea nouchali (Nymphaeaceae): Flowers used for fever, inflammation, cuts and wounds.
- Nelumbo nucifera (Nelumbonaceae): Rhizomes used as diuretic, astringent, anti-diarrheal. Seeds used for cough.
- Eichhornia crassipes (Pontederiaceae): The whole plant used for skin diseases like ringworm, rashes. Leaf juice given for liver disorders.
- Lemna minor (Araceae): Whole plant decoction used for indigestion, dyspepsia, colic pain.
- Azolla pinnata (Salviniaceae): Whole plant paste applied on wounds, boils, glandular swellings. Decoction used for menorrhagia.
- Spirodela polyrhiza (Araceae): Used as poultice for abscesses, hemorrhoids. Juice used for jaundice, urinary infections.

The rich aquatic flora of the region is the basis for its diverse medicinal plant use traditions for primary healthcare needs. Similar studies have also reported wide medicinal uses of these aquatic plants in India and other parts of the world (Kumar et al. 2013; Lakshmanan and Sivaramakrishnan 2018).

Parts used, mode of preparation and administration

Multiple parts of the documented aquatic plants were used in herbal remedies including leaves, flowers, fruits, seeds, rhizomes and the whole plant. Leaves and flowers were the predominant parts used. Fresh parts were typically used for extracting juice while dried parts were generally used for powders, decoctions and other formulations.

The most common modes of preparation were juice, paste, powder and decoction. Other methods like poultice, infusion and chewing of fresh leaves were also reported. The remedies were majorly taken orally for systemic effects. Topical use was also reported for skin diseases, hemorrhoids, wounds etc.

Quantitative analysis results

The use value, informant consensus and fidelity level analyses (Tables 4-6) revealed relative cultural importance and consensus on medicinal uses of the documented plants.

Nymphaea nouchali showed highest use value indicating its cultural significance. Other plants like Nelumbo nucifera, Eichhornia crassipes and Lemna minor also had high use values. The lowest use value was for Hydrilla verticillata suggesting relatively less frequent use.

High informant consensus was seen for digestive and fever/cough remedies. This shows agreement among informants on treating these common ailments with specific aquatic plants. Wound healing and diuretic uses had lower consensus.

For fidelity level, Nymphaea nouchali was preferentially used for fever, Eichhornia crassipes for skin diseases, and Lemna minor for digestive disorders as indicated by greater percentages of informants citing these uses over others.

The results validate the cultural importance, prevalence and traditional knowledge regarding these aquatic medicinal plant species in the Dang region based on statistical consensus.

Comparison with other ethnobotanical studies from similar regions

Some parallels were found between the findings of this study and previous ethnomedicinal studies in similar geographical regions.

An ethnobotanical study by Kumar et al. (2013) in wetland areas of Assam, North-East India also reported several similar aquatic medicinal plant uses:

- Nymphaea spp. for inflammation, cuts, wounds, skin diseases
- Nelumbo nucifera for diarrhea, dysentery, fever
- Lemna spp. for jaundice, dysentery
- Azolla pinnata for boils, wounds

This indicates the widespread traditional uses of these aquatic medicinal plants in different parts of India. Regional similarities as well as differences in ethnomedicinal practices are important to document.

Overall, there are limited studies focused specifically on aquatic ethnomedicinal plants in India compared to terrestrial flora. More intensive surveys across various ecological regions can provide insights into both common and unique folk medicinal uses of aquatic plants.

Most commonly used species and possible phytochemical basis for bioactivities

The quantitative analysis in this study highlighted aquatic species like Nymphaea nouchali, Nelumbo nucifera, Eichhornia crassipes and Lemna minor as the most frequently used medicinal plants in the surveyed region.

Previous phytochemical studies on these species provide hints regarding the chemical constituents underlying their traditional medicinal uses:

- Nymphaea species contain alkaloids like nymphaeine, quercetin and other polyphenols which may account for analgesic, anti-inflammatory activities (Kashyap et al. 2021).
- Nelumbo nucifera rhizomes are rich in alkaloids like nuciferine, flavonoids and tannins which contribute to anti-diarrheal, anti-microbial effects (Mukherjee et al. 2013).
- High tannin content of Eichhornia crassipes leaves gives astringent, anti-inflammatory properties (Prachi et al. 2009).
- Lemna species contain phenolic glycosides like lemnaloside which may provide anti-nociceptive effects (Ray and Ghosal 2018).

Further investigations on bioactive compounds can thus validate the ethnomedicinal utility and optimize extraction of pharmaceutically useful chemicals from these plants.

Limitations of the study

Some limitations should be highlighted in interpreting the study results:

- Sample size was small, focused only on some remote villages which may not represent the entire district
- Seasonal variations in medicinal plant use could not be analyzed

- Toxicity and adverse effects were not systematically evaluated
- Scientific authentication of medicinal properties was not undertaken

More exhaustive surveys across diverse geographical locations and seasons are required. Controlled pharmacological studies are vital to verify therapeutic efficacy and safety of the plants. Bioprospecting of phytochemicals needs to be undertaken before developing phytotherapeutics from these aquatic resources.

In summary, this study provides baseline data on aquatic medicinal flora and associated indigenous knowledge in the Dang region. Further studies are needed to fill research gaps and harness the pharmaceutical potential of these plants in a sustainable manner.

4. Conclusions

This ethnobotanical study documented the rich traditional knowledge and diverse medicinal uses of aquatic plants among indigenous communities in the Dang region of Rajasthan. Fifteen species across ten botanical families were reported to be used by traditional healers to treat various diseases.

Key findings and implications

The extensive data compiled in this study highlights the tremendous significance of the local aquatic flora as a vital healthcare resource for the native people. Quantitative analysis using indices like use value, informant consensus and fidelity level provided valuable insights into the relative cultural importance, consensus and preferential usage of the documented medicinal plants.

Nymphaea nouchali, Nelumbo nucifera, Eichhornia crassipes and Lemna minor emerged as the most culturally significant and frequently utilized species in the surveyed region based on quantitative measures. They form important ethnomedicinal aquatic plants for treating common ailments like fever, inflammation, diarrhea, jaundice and skin diseases through long-standing traditional knowledge.

From a healthcare perspective, the rich aquatic botanical diversity sustains cost-effective, accessible traditional medicine to meet basic health needs in these remote rural communities that lack modern medical facilities. Conservation of the unique wetland ecosystems harboring these ethnomedicinal resources is thus essential not just for cultural heritage but also for public health security of indigenous groups.

However, the lack of proper documentation, validation and recognition of this traditional knowledge is a key concern. Standard ethnobotanical research protocols and quantitative tools as adopted in this study can help systematically record and analyze indigenous healthcare practices related to aquatic medicinal plants. This will provide the foundation to integrate valuable elements of traditional medicine into the modern healthcare system for wider benefit to society.

Significance of traditional ethnomedicinal knowledge of aquatic plants

The diverse medicinal uses of aquatic plants in the Dang region underscore the significance of traditional knowledge systems. These practices and beliefs regarding therapeutic applications of local flora have been orally passed down over centuries.

Elder community members and traditional healers possess rich emperical knowledge about

identification, collection and preparation of herbal remedies from these aquatic plants. For instance, they know the optimal season and habitat to obtain the medicinally potent parts of plants. Such place-based ecological wisdom is integral to effective ethnomedicinal practices.

Women are also custodians of traditional knowledge, especially related to herbs for common ailments, midwifery, child care etc. The gendered nature of folk knowledge requires a nuanced approach in ethnobotanical documentation.

However, erosion of traditional lifestyles due to modernization poses a grave threat to the continuity of this indigenous medicinal knowledge. Commercial overexploitation of medicinal plants is another serious concern. Urgent efforts are needed to systematically record such knowledge and ensure its transmission to younger generations through both documentation and mentoring of traditional healers.

Need for conservation efforts and scientific validation of folk uses

The rich aquatic biodiversity of wetland ecosystems facilitates local ethnomedicinal practices. However, habitat destruction, invasive species, pollution and unsustainable harvesting threaten the survival of many rare, endemic medicinal plant species.

Strategic conservation planning and community stewardship models for ecological restoration of wetlands are required. In-situ preservation of biodiversity hotspots and ex-situ techniques like seed banks for endangered species can be considered. Sustainable harvest protocols and cultivation of highly traded medicinal aquatic plants could reduce pressure on wild stocks.

Scientific authentication of the safety and efficacy of traditional remedies using these aquatic plants is vital before their mainstream approval and commercialization. Isolation of bioactive phytochemicals and elucidating their pharmacological mechanisms through clinical studies can validate ethnomedical claims. Standardization of preparation methods and dosage is also essential. Insights from traditional knowledge can provide focused leads to optimize drug discovery from these natural resources.

Potential for bioprospecting and drug discovery

The findings of this study reveal the immense potential of the documented aquatic plants as candidates for bioprospecting efforts to develop new drugs, nutraceuticals and other therapeutic products. Investigation into the molecular basis of their traditional ethnomedicinal uses can inform targeted screening for bioactive compounds.

For instance, species like Nymphaea, Nelumbo and Eichhornia contain unique phytochemicals from alkaloids to polyphenols which contribute to their anti-inflammatory, antimicrobial, analgesic properties. Sustainable biotechnology techniques can be applied to enhance in vitro production of pharmaceutically valuable compounds from these aquatic plant resources.

However, biopiracy concerns necessitate ensuring fair and equitable benefit sharing with indigenous communities as the traditional knowledge holders regarding any commercial applications. Their participation and approval must be sought in taking forward any drug development from local medicinal plant biodiversity.

This study provides a foundation to understand, validate and harness the rich ethnomedicinal

heritage associated with aquatic plants in the Dang region. It highlights the need for integrating traditional knowledge systems with modern medicine coupled with ecological conservation and ethical bioprospecting for maximizing public health benefits to society.

***Research Scholar**
****Professor**
Department of Botany
Govt. PG College, Kota (Raj.)

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