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TRADITIONAL MEDICINAL PLANTS OF NORTHEAST INDIA: NEW OPPORTUNITIES FOR DRUG DISCOVERY THROUGH MOLECULAR DATABASES

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Northeast India is rich in biodiversity and traditional medicinal knowledge. The region, comprising eight states, supports a wide variety of medicinal plants because of its diverse climate, forests and agroecological conditions. For generations, indigenous communities and rural households have used local plants to manage fever, digestive disorders, skin diseases, wounds and other health problems.

Traditional knowledge offers valuable clues for modern scientific research. Many medicinal plants contain bioactive compounds, known as phytochemicals, that may interact with proteins, enzymes and other biological components of the human body. Studying these compounds can help researchers identify potential candidates for developing new medicines.

However, traditional use does not necessarily prove that a plant can cure a disease. Its chemical composition, effectiveness, dosage and safety must be scientifically investigated before it can be considered for medical applications.

An important development in this field is the North East India Medicinal Plants Database (NEI-MPDB), developed by researchers associated with the CSIR–North East Institute of Science and Technology. The database brings together information about medicinal plants, their traditional uses and their reported chemical constituents, supporting research into natural-product drug discovery.

Medicinal Plant Diversity of Northeast India

The medicinal plants of Northeast India are closely associated with the traditional practices of indigenous communities. Different plant parts, including leaves, roots, bark, rhizomes, flowers, seeds and fruits, are used in traditional preparations.

The NEI-MPDB publication reported 561 unique medicinal plant species and 9,225 phytochemicals. This collection provides a valuable starting point for researchers interested in investigating plant-derived compounds and their possible biological activities.

The database helps connect three important areas of research: traditional knowledge about medicinal plants, information about their chemical constituents, and biological targets associated with diseases.

Important Medicinal Plants for Drug Discovery

Several medicinal plants associated with Northeast India deserve scientific attention because of their reported chemical constituents and biological activities.

1. Kalmegh (*Andrographis paniculata*)

Kalmegh is an important medicinal herb found in several parts of Northeast India. It has been traditionally used for conditions such as fever and digestive disorders. Its major reported constituents include andrographolide and related compounds.

Andrographolide has attracted scientific interest because of its reported anti-inflammatory and other biological activities. Researchers can investigate whether this compound interacts with proteins involved in inflammatory diseases, cancer-related pathways or infectious diseases.

For malaria research, scientists must establish whether a compound can inhibit the parasite at concentrations that are safe for human cells. Computational screening can help identify candidates, but laboratory experiments are necessary to confirm their effectiveness.

2. Guduchi (*Tinospora cordifolia*)

Guduchi, also known as Giloy, is used in several Indian traditional healthcare systems. Its chemical constituents include alkaloids, diterpenoids and other compounds that have attracted scientific interest.

Researchers may investigate individual compounds for their potential effects on inflammatory signalling and metabolic pathways. Molecular databases can help identify suitable candidates for further studies.

However, the safety of Guduchi preparations requires careful consideration, as liver injury has been associated with some products. Its traditional use should not be taken as proof of effectiveness or safety for every condition.

3. Saptaparni (*Alstonia scholaris*)

Saptaparni is a medicinal tree documented in ethnobotanical literature from Northeast India. Its bark and other plant parts have been used in traditional practices. The plant contains indole alkaloids, a group of compounds known for their diverse biological activities.

Researchers can investigate whether specific alkaloids interact with proteins essential for the survival of malaria parasites or other pathogens. Such studies may help identify new molecular candidates for antimicrobial research.

Any promising findings must be confirmed through appropriate laboratory testing and toxicity assessment.

4. Mishmi Teeta (*Coptis teeta*)

Mishmi teeta is associated particularly with Arunachal Pradesh and the traditional knowledge of communities in the eastern Himalayan region. Its rhizome contains alkaloids, including berberine.

Berberine has been studied for various biological activities, although its effectiveness and safety depend on the condition, preparation and dose. Researchers can use molecular databases to investigate the interactions of berberine and other compounds with selected disease-related proteins.

5. Nayantara (*Catharanthus roseus*)

Nayantara, also known as Madagascar periwinkle, is widely cultivated as an ornamental plant in India. It is an important example of how medicinal plant research can contribute to modern medicine.

The plant produces vincristine and vinblastine, compounds used in certain cancer treatments. These medicines demonstrate the potential of natural products to provide valuable starting points for pharmaceutical development.

6. Tulsi (*Ocimum tenuiflorum*)

Tulsi is widely cultivated in household gardens and has a long history of use in traditional Indian medicine. Its leaves contain compounds such as eugenol and other phenolic and terpene constituents.

Some of these compounds have demonstrated biological activities in experimental studies. Researchers may investigate their interactions with selected proteins associated with inflammation, oxidative stress and infectious diseases.

The chemical composition of Tulsi can vary with the plant variety, growing conditions and harvesting methods. Therefore, standardised chemical analysis is important for reliable research.

Molecular Databases and Modern Drug Discovery

Molecular databases are valuable tools for connecting traditional medicinal knowledge with modern biotechnology. They allow researchers to examine plant-derived compounds, retrieve chemical structures and investigate possible interactions with disease-related proteins.

In addition to NEI-MPDB, researchers can use several complementary resources:

- IMPPAT: <https://cb.imsc.res.in/imppat/> — provides information on Indian medicinal plants, phytochemicals and their reported associations.
- PubChem: <https://pubchem.ncbi.nlm.nih.gov/> — provides chemical structures, identifiers and molecular properties.
- Protein Data Bank: <https://www.rcsb.org/> — provides three-dimensional structures of proteins and other biological molecules.

Using these databases together can help researchers verify compound identities, identify potential molecular targets and prepare candidates for computational screening.

How Molecular Docking Helps

Molecular docking is a computer-based technique used to estimate how a small molecule may interact with a protein. It is widely applied during the early stages of drug discovery.

For example, a researcher investigating malaria may identify phytochemicals from plants traditionally used for fever. The researcher can then select a validated protein target of the malaria parasite and use docking software to examine whether any of the compounds may interact with it.

The results can help prioritise compounds for further investigation. However, a favourable docking score does not prove that a compound can treat malaria or any other disease.

Promising candidates must undergo laboratory testing to determine their biological activity, selectivity and toxicity.

Researchers may also use computational methods to predict absorption, distribution, metabolism, excretion and toxicity. These predictions can help identify potential limitations before expensive experiments are conducted.

Potential Applications in Serious Diseases

Malaria

Malaria is an important area for medicinal plant research in Northeast India. Ethnobotanical studies have documented numerous plant species traditionally used to manage malaria and associated symptoms.

Researchers can combine these records with phytochemical databases to identify candidate compounds for investigation against Plasmodium parasites. The strongest candidates must be tested in appropriate laboratory assays to establish whether they can inhibit the parasite without causing unacceptable harm to human cells.

Traditional remedies must not replace diagnostic testing or proven antimalarial medicines.

Cancer

Cancer research is another important area for natural-product drug discovery. Researchers can investigate whether plant-derived compounds influence proteins associated with tumour growth, cell division or programmed cell death.

The discovery of vincristine and vinblastine from *Catharanthus roseus* demonstrates the contribution of plant-derived molecules to cancer treatment.

Nevertheless, most compounds identified through computational screening will require extensive investigation before their suitability for medical use can be established.

Diabetes and Metabolic Disorders

Certain plant-derived compounds are being investigated for their potential effects on enzymes and pathways involved in glucose metabolism. Molecular databases can help researchers identify compounds for further study.

However, predicted interactions with metabolic enzymes do not establish that a plant can control diabetes. Laboratory studies, safety assessments and appropriate clinical research are required before therapeutic claims can be made.

Antimicrobial Resistance

The increasing resistance of some pathogens to existing medicines has created a need to explore new chemical structures. Medicinal plants may provide useful starting points for investigating compounds that inhibit microbial growth or affect essential microbial proteins.

Researchers must confirm these effects through laboratory experiments and determine whether the compounds are safe and effective against relevant pathogens.

From Computational Screening to Laboratory Validation

Successful drug discovery requires several stages of investigation. First, researchers must identify the plant correctly and verify its reported chemical constituents. Next, suitable compounds are selected for computational screening against disease-related targets.

Promising candidates may then undergo additional modelling, chemical analysis and laboratory experiments. These studies establish whether the predicted interactions translate into measurable biological activity.

Further research may include toxicity testing, pharmacokinetic studies and preclinical investigations. Only candidates supported by sufficient evidence can proceed towards clinical trials and possible pharmaceutical development.

This step-by-step approach helps researchers use limited resources more efficiently while reducing the risk of drawing conclusions from computational predictions alone.

Opportunities for Agriculture and Rural Livelihoods

Medicinal plant research also offers opportunities for agricultural development and rural entrepreneurship. If a plant or its compounds become important for scientific or commercial applications, farmers may benefit from the development of suitable cultivation practices and reliable supply chains.

Agricultural research can support the selection of suitable varieties, propagation techniques, soil and nutrient management, harvesting methods and post-harvest processing. These interventions can improve plant quality and help maintain consistent levels of important phytochemicals.

Farmer producer organisations, rural entrepreneurs and community institutions may also explore medicinal plant nurseries, cultivation, authenticated raw material production and quality-controlled processing, subject to actual market demand and applicable regulations.

At the same time, conservation must remain a priority. Unsustainable harvesting of roots, bark or whole plants can damage natural populations. Cultivation and responsible collection practices can help reduce pressure on wild resources.

Commercial opportunities should be developed only after assessing market demand, production costs, environmental impacts and the requirements of potential buyers.

Protecting Traditional Knowledge and Biodiversity

The medicinal plant wealth of Northeast India is closely connected with indigenous knowledge preserved over generations. Research and commercial development must respect the communities that maintain this knowledge.

Researchers should obtain appropriate consent before documenting community-held knowledge, follow applicable biodiversity regulations and establish fair benefit-sharing arrangements where required.

They should also acknowledge knowledge holders, protect culturally sensitive information and avoid practices that threaten vulnerable plant species.

Ethical research can help ensure that scientific progress benefits not only researchers and commercial organisations but also the communities whose knowledge contributes to discovery.

Conclusion

Northeast India possesses an exceptional combination of medicinal plant diversity, traditional knowledge and opportunities for modern scientific research. Resources such as NEI-MPDB can help researchers connect ethnobotanical information with chemical structures and computational drug discovery.

By combining traditional knowledge with molecular docking, bioinformatics, laboratory testing and agricultural research, scientists can identify promising natural compounds for further investigation into malaria, cancer, metabolic disorders and infectious diseases. However, the identification of a potential compound is only the beginning of drug discovery. Its effectiveness, safety and suitability for human use must be established through rigorous scientific research.

For the agricultural sector, medicinal plant research can also encourage sustainable cultivation, biodiversity conservation and new livelihood opportunities. Collaboration among farmers, indigenous communities, agricultural institutions, chemists and medical researchers will be essential to realise this potential.

Traditional knowledge can guide scientific discovery, molecular databases can help identify promising candidates, and experimental evidence must determine whether those candidates can become safe and effective medicines.

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