From Ancestral Wisdom to Algorithmic Insight: The Role Of AI in Modern Ethnobotanical Research

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Abstract

Worldwide around 80% population are dependent on the medicinal knowledge for their treatment in the developing countries. Our ancient knowledge provides us the data about the presence of many phytochemicals inside the medicinal plant with the specific healing properties. Ethnobotany is the study of the interaction between plants and human civilization. As in the recent times, AI prove its utilization in all the field, ethnobotany should also integrate it to open the new door for the research related to plants. These article deals with the role of AI in case modern ethnobotanical research.

KEY-WORDS: Ancient Knowledge, Artificial Intelligence, Biodiversity, Ethnobotany, Medicinal Plant, Modern, Research, World Health Organization.

ABBREVIATION:

- AI: Artificial Intelligence
- ANN: Artificial Neural Networks
- BOLD: Barcode of Life Database
- CAD: Computer-Aided Design
- CNN: Convolutional Neural Network
- DNA: Deoxyribonucleic acid
- DTR: Decision Tree Regressor
- GBIF: Global Biodiversity Information Facility
- GBR: Gradient Boost Regression
- GIS: Geographic Information Systems
- NLP: Natural Language Processing
- SVM: Support Vector Machines
- SVR: Support Vector Regression
- TKDL: Traditional Knowledge Digital Library

- WHO: World Health Organization

INTRODUCTION:

Medicinal plant is a rich source of information from the ancient times in every cultures due to their various properties esp. in health care sector.[1] Plant is in close relationship with complex socioecological system because it contains many bioactive compounds like, phenolic, carotenoid, anthocyanin which are known for their antioxidant, anti-allergic, anti-inflammatory, and antibacterial actions. World-wide, 3 to 5% in developed countries and 80% in developing countries relay over medicinal plant-based treatment.[1][2][3] That is why research in this segment is very crucial and important.[1]

Raj et al. stated that “traditional medicine research is not only concerned with thee pharmacological effects of plants but also involves the relationship between traditional knowledge and modern medical practices.” [4]

Ethnobotany is an interdisciplinary study which deals with the interaction between plants and human civilization by integrating botany, anthropology and ecology which provide protection to biodiversity, cultural heritage to understand the utilization of the plants in healthcare, food, rituals, ecological management, and for the sustainable development. It is not just the superficial palpation of the information, but a plant which is growing in both direction where his roots are tracing back till the 20th century by some pioneers to understand the progression and growth.[2] Ethnobotany term is coined in 1895 by W. Harshberger & derived from the Greek word for “people-ethnos” - and “plants-botane”.[3]

Continue progress of medicinal knowledge require ethnobotany which is a bridge between traditional knowledge and modern science by offering valuable insights into the medicinal use of plants that are deeply rooted in cultural heritage.[5] Many medicinal plants like QUININE, DIGITALIS, etc. has contributed in the modern pharmacology as well as help in formation of ecofriendly plant based sustainable alternative synthetic product.[2] According to statistical data 14% to 28% plant has medicinal properties.[1] More than 25% medicine are derived from the plant sources & WHO consider 252 pharmaceuticals as an essential.[3] It helps in the preservation of traditional culture as well as help in the development of drug and community health care system.

Among all the different branches of the ethnobotany, ethnomedical practice help to compresence the relationship between indigenous communities and nature which help to understand biological diversity of the specific reginal planets. The knowledge and data provided by the ethnomedical practice will help for the better progression and development.

But it has some challenges in situation and condition like, preservation and utilization of this knowledge as data fragmentation, loss of oral traditions, biopiracy, habitat loss, intellectual property disputes and a lack of systematic documentation.[2][5] India is a quite fascinating place to study different plant because of the availability biodiversity but unfortunately our centuries old knowledge is being lost day by day which create a future problem for the mankind.[3]

A process of understanding and analyzing the different medicinal plant are a tedious, time consuming which require experience specialist who apply his reason gifted intelligent mind to dig out the truth of the nature.

Information technology is drastically changed the way of science and research in recent yearsIf modern technological advancement will be paired with human expertise than the outcomes can be more innovative and culturally sensitive rather than using either entity works in isolation.[6][7]

Modern Advancement and Ethnobotany:

DNA Barcoding: A technique help to identify plant species by using a short DNA sequence.

Phylogenetic Analysis: Reconstruction of the evolutionary history of plant species and their relationship.

GIS: To analyse and visualize data related to plant distribution, habitat, significance. and culture.

Ethnobotanical Databases: Digital repositories of ethnobotanical data includes utilization, distribution, and clinical significance of the plant.

CAD: Create digital models of plant structures to study their morphology and anatomy.[2]

Among all these advancements, the artificial intelligence plays a crucial role to enhance the boundary for the betterment of the mankind.

Artificial Intelligence:

In recent times, AI is transforming research methods in many different scientific fields.[8] AI-driven tools have potential to maintain the ethnicity as well as provide modern changes and solution to the old problems related to ethnobotanical research. In context of ethnicity, it Maintain data sovereignty, intellectual property rights, and cultural sensitivity and as modern solution it provides digitalization, analysis and management of traditional knowledge.[9] In recent times, it emerges as an answer of questions regarding herbal medicines and their known and unknown potential.[6]

From ancient times a rich heritage of human interaction with nature is represented by traditional medicinal plant and knowledge. The way of transmission of this knowledge is usually a “ORAL” one from generation to generation within communities or families leads to misinterpretation as well as loss of information over period of time because of the lifestyle changes, and globalization. This knowledge help to find the potential role of reginal plants by using their characteristic action like, antioxidant, antimicrobial, and antifungal, etc. [5]

Globally the use of AI is increasing in all the sectors esp. in the research because of its vast database. These characteristics are showcase by its name which made up by 2 word Artificial and Intelligence, a programmed database which provide answer to the queries by applying a perceived data or information according to the provided environment.

As Sternberg stated, “intelligence is the ability to acquire knowledge from experience and respond to, change, and select one’s environment.” [10]

AI known for performing cognitive functions like facilitating learning, reasoning, and self-correction which are performed by machine or computer systems as if it possesses knowledge of human behavior.[6]

The villain of the ancient knowledge – Globalization, is only providing a solution also in the form of digitalization which help in documentation for the future use. It helps the cultural preservation as well as provide the way for innovation and collaboration of different pharmacological substances to know and utilize their biodiversity for the betterment of the human kind. Platforms like, TKDL increase accessibility of traditional knowledge to the modern man on a global scale which break down geographical barriers and facilitating cross-cultural sharing. Like, a person sitting at the one corner of the world may access the knowledge of regional plant from another corner without applying any physical means and saving a much amount of time by using digital platforms.

Importance of Digitalization:

- Help in preservation of ancient wisdom.
- Enhance innovation in the field of medicine.
- Improvement of accessibility.[5]
- Techniques like phylogenetic studies, virtual screenings, and in silico modelling help to identify patterns and relationships between plant species and their medicinal applications.[11]

Role of AI in Traditional and Herbal Drug Discovery:

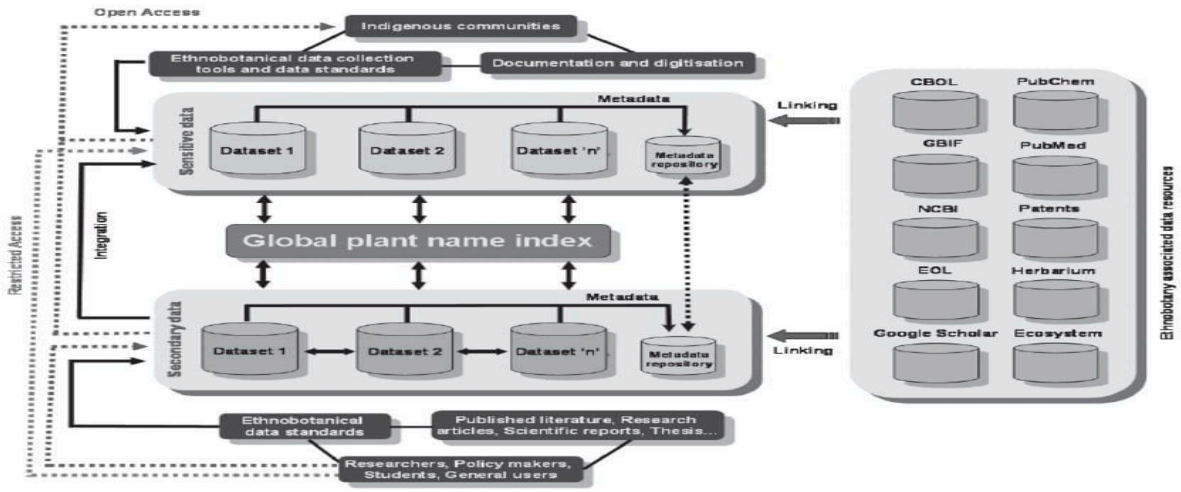
Tools like machine learning, deep learning, and data mining has specialized AI algorithms analyze vast repositories of ancient texts, research papers, and clinical data to extracted valuable information & identify patterns and correlations between specific herbs and their effects on various health conditions across different cultures.[6][7]

It helps in “IMAGE RECOGNITION” also to identify new plants and drugs in context of leaves, flowers, roots, and stems, etc.

Disease-Specific Herb Recommendations provided by using machine learning techniques to correlate the properties of herbs with particular health conditions or diseases.

It helps in cultivating medicinal plants by following means,

1. Analysing soil
2. Croup growth monitoring
3. Prediction of weather pattern
4. Enhance the irrigation and fertilization of soil.
5. To diagnose the plant disease
6. Screening of active compounds.



Schematic representation work of AI for ethnobotanical data [12]

SOME AI PLATFORM OR SOFTWERE:

- Deep learning-based platform: Produce unique chemical structure leads to discovery of a new class of drugs with anti-fibrotic capabilities.
- Chemception model.6 3 - University of Toronto: Help to predict the bioactivity of chemicals derived from herbal sources.
- Near-infrared spectroscopy: Detect specific chemical markers in herbs.
- NLP: Analyse vast amounts of textual data and extract valuable information about the characteristics, properties, and traditional uses of herbs.
- Multi-layer Perceptron SVR, DTR, and GBR - Liu et al.: Poly-pharmacology prediction model to predict 20 candidates with potential effects against drug-induced liver injury (DILI).
- Swiss ADME network tool: Prediction of physicochemical properties, pharmacokinetics, drug similarity and drug chemical compatibility.
- SVM and ANN: Identify the characteristic spectral or chromatographic fingerprints which is unique to authentic herbal products to distinguish between genuine and adulterated herbal samples leads to enhancement of product authentication and quality assurance.
- CNN: Image segmentation and pattern recognition.[6]
- NAPRALERT: information about 20,000 medicinal plants.

Database/ Tool	Primary focus	Application	Relevance to Traditional Knowledge
BOLD	Genetic Data (DNA Barcoding)	Species identification, Biodiversity research	Validation of medicinal plant species
TKDL	Traditional Practices	Biopiracy prevention, Research collaboration	Documentation & protection of indigenous knowledge

GBIF	Biodiversity Data	Conservation, Ecological studies	Distribution mapping of medicinal plant
Free DELTA	Taxonomic Data	Dataset management, Taxonomic analysis	Standardization of plant classification
NaviKey Server	Taxonomic Identification	Interactive identification, Education	Accurate classification of medicinal plant [11]

CONCLUSION:

AI is an irreplaceable part of today's world because of its integration into all the field esp. health care sector. Ethnobotany is system which protect the ancient knowledge of the medicinal herbs. If a modern technology like AI and ethnobotany work as a two side of the coin than the preservation of the biodiversity as well as research of the new potential medicines to combat the end number of diseases. Many AI software like, BOLD, GBIF, NLP, etc is available which help in different segment in the ethnobotany.

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