Life Sci. Res. Commn., 2024; 1(1):31-41.
https://lifesci.com.sg

Original Article

Medicinal Plant Databases: Analyzing Strengths, Weaknesses and Innovations for Future Improvements

Sabiha Naaz, Vishal M Balramnavar, Arminder Kaur

Department of Biotechnology, Sanskriti University, Mathura, Uttar Pradesh, INDIA.

ABSTRACT

Medicinal plants have played an important role in medicine due to their ability to bind and play cellular targets active in disease. Medicinal plants hold a variety of bioactive scaffolds for the treatment of many disorders. Medicinal plants have few harmful effects, affordability, and simple accessibility and their potential in traditional remedies. Identifying pharmacological targets from active components of medicinal plants has become a hot topic for biomedical research to generate innovative therapies. For organizing new scientific literature produced in the medicinal plant field, as well as new drug discoveries in the information era have become an important part of plant databases. This review article aimed at analyzing the currently available plant databases. PubMed and Google are used for searching for finding medicinal plant databases. PubMed was used for searching for papers presenting medicinal plant databases as a search strategy. Google was also used for searching medicinal plant databases. The current access to plant databases and the features, its URL, its strength, its weakness and the innovation of the plant databases were mentioned in this review article. The reviewed databases had a large group of information in terms of characteristics and innovation. Finally, some recommendations for the efficient improvement of plant databases were suggested. This review article may not cover all the required information, but can give readers key concepts, views, and suggestions for building many useful plant databases.

Keywords: Medicinal plant database, Botanical database, Plant taxonomy database, Plant biodiversity database, Herbal medicine database, Google was also searched for medicinal herbs databases.

Correspondence:
Dr. Arminder Kaur
Department of Biotechnology,
Sanskriti University, Mathura,
Uttar Pradesh-281401, INDIA.
Email: arminder.smas@sanskriti.edu.in

Received: 04-02-2024;
Revised: 16-03-2024;
Accepted: 01-04-2024.

INTRODUCTION

In the ancient period, medicinal plants were used in different kinds of current medical systems and also used in ancient medical systems. It also helps in the treatment of various kinds of disease. According to ancient evidence, ~60,000 years ago, many medicinal plants were used as drugs (Dinda and Saha, 2022). Many people use medicinal plants for the treatment of different kinds of diseases (Maran *et al*., 2022). They are viewed as treating nature (Naghizadeh *et al*., 2020). But currently, the use of these medicinal plants only as alternative medicines is increasing around the world, like in India, China, Germany (Bultum *et al*., 2019). Mathematical statistics show that ~80% of the world's population uses medicinal plants or their parts as medicine for treatment of different types of diseases (Sawada *et al*., 2018). The large number of medicinal plants are used widely in European Union countries (Chen, 2011). In some countries, phyto medicinal plants or medicinal plants are part of their modern health-care systems (Zeng *et al*., 2018). Medicinal plants are called on of five main parts classic likes naturopathy (phytotherapy, hydrotherapy, exercise therapy, dietetic therapy and 'lifestyle regulation' therapy) (Joos *et al*., 2012). There is great interest in many different groups of health care, like pharmacists and non-medical medicine practitioners, are interested in medicinal plants (Beer and Ostermann, 2003). Medicinal plants are used in the official healthcare system in China (Wu *et al*., 2019). About 95% of general hospitals use medicinal plant database in traditional medicine departments and Traditional Chinese Medicine (TCM) for treatment of different kinds of diseases patients (Agyei-Baffour *et al*., 2017).

Also in India, an acronym for Ayurveda, Yoga and Naturopathy, Unani, Siddha, Sowa-Rigpa and Homeopathy (AYUSH) is a well-organized department giving health-care services in both departments, public and private. AYUSH has a wider view empower in decreasing the burden of disease and tries to encourage these systems and mix this organization with conventional medicine (Rudra *et al*., 2017). An effective segregation scheme will encourage communication and mutual understanding among various medical systems, measure medical

DOI: 10.5530/lsrc.1.1.8

Publishing Partner : ScienScript Digital. [www.scienscript.com.sg]

care in its totality, ensure just concentration of resources, give a training and educational program for both traditional medicine and conventional medicine, (AYUSH) and conventional medicine are sharing information between them are very important for the development for medicinal plants database. Currently, there is a limited amount of information about medicinal plants database available in journals, manuals and textbooks (Mohanraj *et al.*, 2018). Recently, with the spread of scientific databases, a unique way has been formed of sharing information on medicinal plant databases. These medicinal plant databases collect and give information on medicinal plants, medicinal herbs, ingredients, 2D/3D structures of compounds, related target proteins, relevant diseases and metabolic toxicity, which are primary in medicinal plant database herbs for further research studies for scientists, physicians and pharmacists (Wang *et al.*, 2009). They assist in many ways of biological research, containing information about a gene or a protein and complex applications for research work (Narayanan *et al.*, 2022). These databases become more useful when there is a correct volume of information, its correct interpretation and the regular updating of the content takes place in it (Danisman, 2016).

Medicinal plants are the leading sources of numerous expensive chemicals and/or drugs. Over 1300 medicinal plants are utilized in European countries, 90% are from wild sources. According to the International Union for Conservation of Nature and the World Wildlife Fund, about 50,000-80,000 flowering plants are utilized because of their medicinal values (Britan *et al.*, 2018). Also, the National Medicinal Plant Board India has estimated that India has 17,000-18,000 species of flowering plants, out of which 6000-7000 are known to have medicinal application ancient medicinal systems such as ayurveda, siddha, unani, and homeopathy. About 960 medicinal plants are in the trade industry, of which only 178 are known to have annual consumption levels of more than 100 MT (metric tons) (Dankar *et al.*, 2018). The increase in human population and the demand for natural medicines have aggravated the loss of medicinal plant species, 100-1000 times the rate of natural extinction. Although this threat has been known for decades, it has resulted in the increase in loss of species and habitat destruction worldwide. This chapter reviews advances in the application of tissue culture for the in vitro regeneration of rare endangered or threatened medicinal plants and enhancement of various pharmaceutics, drugs, flavors, colors, and medicinal compound production in medicinal plants (Kerwin, 2010). Medicinal plants have been utilized in traditional medicine in the worldwide so it's refereed as ethno medicine (Ningthoujam *et al.*, 2012). This review article gives a presents a view of the present-day status of and future direction in medicinal plant database. These medicinal plant databases are at the junction of phytochemistry and plant biology.

It also causes achievement in evolution mechanisms and systematic of medicinal plant genomes, origin and evolution of plant genotype and metabolic phenotype, interaction between medicinal plant genomes and environment, and correlation between gnomic diversity and metabolite diversity, etc (O'Boyle *et al.*, 2011). The use of medicinal plant databases the emerging high-end genomics technologies. It can also be enlarged from crop plants to traditional medicinal plants to action the medicinal plant breeding and transform them into the living factory of medicinal compounds. The utility of medicinal plant database in molecular phylogeny and phylo genomics in predicting chemo-diversity and bio prospecting is also particular within the context of use of natural product-based drug discovery and development ("UniProt: A worldwide hub of protein knowledge," 2018). The symbolic case studies of medicinal plant genome, phylogeny, and evolution are concise to illustrate the discussion of knowledge pedigree and the examples like omics-based approaches (Li *et al.*, 2018). The Medicinal plant database updates our awareness about plant genome evolution and enables the molecular breeding of medicinal plants and the sustainable utilization of plant pharmaceutical resources (Sorokina and Steinbeck, 2020). Plants also makes a large number of orangic compounds, some of organic compounds are present in large quantity in plant but these are not directly involving in growth and development (Bodenreider, 2008). These organic compounds are known as Plant Secondary Compounds (PSC), and play an important role in the contribution of all plant kingdom taxonomies. These plants' secondary compounds also play an important role in major activities in limited colors, tastes and odors, as well as limited defense properties in all plants (Lagorce *et al.*, 2017).

These plant secondary compounds are also used as traditional medicines and pharmaceuticals for human beings. For example, the bio-active molecules of green tea being used in the prevention of obesity or the growth of the cardiovascular system (Degtyarenko *et al.*, 2007). The phytochemical Compounds are present in plant *Cannabis sativa*, which is known as phyto cannabinoids, are used as therapeutic tools in cancer, central nervous system disorders, epilepsy, and other health problems (Gaulton *et al.*, 2011). These Plant Secondary Compounds (PSC) contains phenolic compounds such a resveratrol, present in grapes and wine, have shown medical neuron-protective properties (Shahin *et al.*, 2021). There are about 100 natural product databases that have been created in the last 20 years. There are some examples of natural products databases like SuperNatural II, The Universal Natural Products Database, NP Atlas ZINC, NPASS, BindingDB, NPEdia, 3DMET, and the CNPD (Pence and Williams, 2010). Some of phyto chemical Compounds are only as a facility of chemical compounds. Some of phyto chemical Compounds are present in the relative quantity in the databases but do not allow for the state, activity (Meng *et al.*, 2022). Upload of all the structural and physico chemical features of a particular set of compounds. Upload of all the structural and physico chemical features of a particular set of compounds (Nguyen-Vo *et al.*, 2019). Also, in other cases, there is no link to related or original databases.

Table 1: Inclusion and exclusion criteria for medicinal plant databases.

Inclusion criteria	Exclusion criteria
(i) Medicinal plant databases. (ii) Cost of free access database. (iii) Regular update database. (iv) Free access databases.	(i) Inaccessible databases. (ii) Websites/servers no longer available. (iii) Databases with unavailable access links.

Without these characteristics and considering the large number of molecules that are currently registered in public databases, a given repository of biological information might not be useful (Jamal *et al.*, 2016).

In addition, some databases include experimental and computer-based characteristics of the stored compounds, but they often do not consider additional analyses or correlations between the data. Remarkable, our database allows finding molecules by name or structure, to group and bulk downloading of properties and structures (Chen *et al.*, 2021). Moreover, all compounds are linked to the original sources and for most cases, several new physicochemical features were calculated and are available. It is also worth pointing out that the conventional discovery of new bio active compounds from natural resources requires laborious screening of several compound libraries. However, with increasing insights into the structure function relationship of target proteins, today it is possible to screen virtually those large chemical libraries, as well as subsets of known compounds to predict new activities (Mumtaz *et al.*, 2016). Although a large number of databases have been created over the years, it is currently not possible to efficiently extract delimited 3D-structural information along with physicochemical and pharmaceutical ones of a given group of plant secondary compounds needed to perform such screens. Modern medicinal plant databases are different in stored total of data, specialization, functionality and type of access (Farsani *et al.*, 2020). But with a few exceptions, all databases have large amounts of data and contain complex information from multiple sources (Visser and Weideman, 2011). Medicinal plant databases are a group of the same specifications, taxonomy, common names, location, medicinal uses and used parts, and modern scientific information, including physicochemical properties, ingredients, genomics information, mechanisms of action are available in medicinal plants databases.

The information is stored in the format of texts or images. Medicinal plant databases play more economic role in new drug discoveries in the future research work. Currently, the contribution of medicinal plants in drug discovery helps in the construction of many new databases with advanced features and the fall of numerous databases (Apweiler, 2004). Medicinal herbs databases now main focus on phytochemical and physicochemical properties due to new efforts for drug discovery from medicinal plant. For increasing demand for medicinal plant databases and their contents, it is necessary to have more up-to-date and efficient future design.

OBJECTIVES

The aim of this review article is to study the current types of medicinal plant databases, and mainly focus on their unique features, their URLs, strength and their weaknesses. To collect information on medicinal plants, categorize databases based on definite features, like

Based on Data Types

Phytochemical Databases, Pharmacological Databases, Ethnobotanical Databases, Clinical Trial Databases.

B. Based on Geographical Focus

Global Databases, Regional Databases (e.g., databases focusing on specific continents or countries).

Based on Plant Families

Databases categorize plants based on their botanical families.

D.User Interface and Accessibility

Web-based Databases, Desktop Applications, Mobile Applications.

METHODOLOGY

Finding a list of medicinal plant databases was carried out via Google and PubMed. A search of published papers introducing medicinal plant databases found by a Google scholar. Both published papers and databases were reviewed by the authors. Research Papers with an active database on the web were included in the review. To collect information on plants, categorize databases based on definite features, like all the reported databases in this review article provide information about the list of plants, their features, used part (i.e. roots, leaves, seeds, flowers and fruits), common names and their synonyms that were collected from various resources (e.g. traditional medicine textbooks/ online databases, scientific journals and National Center for Biotechnology Information (NCBI) Taxonomy).Inclusion and exclusion criteria for databases are described in Table 1.

Plants databases are categorized according to based on definite features, like content type, facilities/features, status of the URL. Discuss about the strength and weaknesses of databases. Also, discuss about some of the unique features or innovations of the databases. In Table 2, show that plant databases are categorized based on definite features, like content type, facilities/features its URL. Phytochemical Databases give information about molecular structures/properties, Absorption, Distribution, Metabolism, Excretion and Toxicity (ADMET)-related properties and ingredients have been gathered in plant databases from computational methods (e.g. online specialized chemical databases such as Phytochemical and Ethnobotanical Databases (PEB), Indian Medicinal Plants, Phytochemistry and Therapeutics 2.0 (IMPPAT 2.0)(Mohanraj *et al.*, 2018), PubChem, ChEBI (Boyle *et al.*, 2013), ChEMBL(Jones *et al.*, 2011), ChemSpider, ChemBioOffce (Hussain *et al.*, 2021), Balloon and Open Babel, FAF-Drugs4 web server and RDKit (Brockdorff and Wei, 2021). Pharmacological Databases give information on the pharmacological effects and traditional utility of medicinal herbs (Mahmud *et al.*, 2022), such as HerbMed, Herb Database (Herbal Medicine Resource) etc. Ethnobotanical databases help

Table 2: **Plant Databases and their features.**

Based on Data Types		
Phytochemical plant Databases	**Features**	**URL sites**
Phytochemical and Ethnobotanical Databases (PEB).	Extensive information on phytochemicals, ethnobotanical data, and plant taxonomy.	http://phytochem.nal.usda.gov/
Indian Medicinal Plants, Phytochemistry,and Therapeutics 2.0 (IMPPAT 2.0).	It extensive platform transcends traditional boundaries, seamlessly integrating phytochemistry, medicinal properties, and therapeutic applications.	https://cb.imsc.res.in/imppat/.
PDTDB: Phytochemical and Drug Target DataBase.	PDTDB provides keyword or accession number search, similar small molecule search using SMILES string or by drawing the 2D diagram of the chemical structure, small molecule with similar molecular formula search by clicking the hyperlinked molecular formula on the web page, structure activity relationship search, and browse and/or search from the sortable tables to access the entries in the database. It supports 3D structure download and visualization for each molecule. Each record of the plants, phytochemicals, diseases and drug targets are hyperlinked to the related entries and reference to the original resource.	https://pdt.biogem.org
Phytochemica: a platform to explore phytochemicals of medicinal plants.	Phytochemica is an exhaustive resource of natural molecules facilitating prospecting for therapeutic molecules from medicinally important plants.	home.iitj.ac.in/~bagler/webservers/Phytochemica
OSADHI - Online Structural and Analytic based Database for Herbs of India.	It is one of the largest manually curated databases which have been constructed with the concept of "4Ds-Documentation, Digitization, Deposition and Data Science". The information in this database has been collected from books, published articles and other existing open sources.	OSADHI - Index (neist.res.in)
Pharmacological plant databases	**Features**	**URL sites**
HerbMed	Give information on the pharmacological effects and traditional utility of medicinal herbs.	http://herbmed.org/
Phytochemica	Focusing on phytochemicals and their pharmacological activities.	https://phytochemica.org/
Herb Database (Herbal Medicine Resource).	Extensive database on medicinal herbs, with information on traditional utility, pharmacology.	https://www.herbmed.org/
Medicinal Plant Database (MPDB).	It includes information on the pharmacological of medicinal plants, state secondary metabolites.	http://mpdb.mpipz.mpg.de/

Ethnopharmacology Database.	Focusing on the traditional uses and pharmacological properties of plants used in diverse cultures.	https://www.ethnopharmacology.org/
Ethnobotanical plant databases	**Features**	**URL sites**
Ethnobotanical Database of Bangladesh (EDB).	Focuses on the traditional uses of plants in Bangladesh, providing ethnobotanical information.	http://www.ebbd.info/
African Ethnobotany Database (AEDB).	Aims to document and share information on the traditional uses of plants in Africa.	https://www.africa.ethnobotany.org/
Dr. Duke's Phytochemical and Ethnobotanical Databases.	It facilitate in-depth plant, chemical, bioactivity, and ethnobotany searches using scientific or common names.	(usda.gov)
Medicinal Plant Database (MPDB).	Add ethnobotanical data, focusing on medicinal plant uses and traditional knowledge.	http://mpdb.mpipz.mpg.de/
Global Plant Council's Ethnobotany Database.	Give a platform for joint ethnobotanical knowledge globally.	https://globalplantcouncil.org/ethnobotany-database/
Ewé: a web-based ethnobotanical database for storing and analysing data.	Ewé provides tools for the visualization of large datasets, facilitating hypothesis generation and meta-analyses.	www.ewedb.com.
Clinical plant databases	**Features**	**URL sites**
ClinicalTrials.gov	An extensive database of privately and publicly funded clinical studies conducted in the world finds clinical trials incidental to herbal medicines and plant-based treatments.	https://clinicaltrials.gov/
PubMed	A vast database of biomedical literature, including studies on the clinical effects of medicinal plants and herbal remedies.	https://pubmed.ncbi.nlm.nih.gov/
DIMPSAR: Datasets for Indian medicinal plant species analysis and recognition.	Systematic reviews on the effectiveness of healthcare interventions, including those related to herbal and plant-based treatments.	https://www.cochranelibrary.com/cdsr
Natural Medicines Database.	It provides evidence-based information on herbal medicines, including clinical effectiveness, interactions, and safety.	https://naturalmedicines.therapeuticresearch.com/
IMPPAT: A curated database of Indian Medicinal Plants, Phytochemistry and Therapeutics.	Provides an integrated platform to apply chem informatic approaches to accelerate natural product-based drug discovery.	https://cb.imsc.res.in/imppat.
Global plant databases	**Features**	**URL sites**
Global Biodiversity Information Facility (GBIF).	It is an international network and data infrastructure funded by the world's governments and aimed at providing anyone, anywhere, open access to data about all types of life on Earth.	https://www.gbif.org/
Flora of North America (FNA)	It presents for the first time, in a published reference source, information on the names, taxonomic relationship, continent-wide distributions, and morphological characteristics of all plants native and naturalized found in North America north of Mexico.	http://www.efloras.org/flora_page.aspx?flora_id
The Plant List	A combined state offers a working list of recognized plant species names and words on a global scale.	http://www.theplantlist.org/

World Flora Online (WFO)	World Flora Online is an Internet-basedcompendium of the world'splant species open access database.	http://www.worldfloraonline.org/
Tropicos	Tropicos is an online botanical database containing taxonomic information on plants, mainly from theNeotropical realm (Central, andSouth America). It is maintained by theMissouri Botanical Garden.	http://www.tropicos.org/
Regional plant databases	**Features**	**URL sites**
Flora of China	A large asset gives data on the flora of China, including descriptions, illustrations, and distribution maps.	http://www.floral.org/flora_page.aspx?flora_id=2
Australian Plant Name Index (APNI)	The Australian Plant Name Index (APNI) is an online database of all published names of Australian vascular plants. It covers all names, whether current names, synonyms or invalid names.	https://www.anbg.gov.au/cgi-bin/apni
Brazilian Flora 2020	The project's aim is to record and identify the flora of Brazil, give taxonomic and distribution information.	http://floradobrasil.jbrj.gov.br/
Flora Europaea	Focuses on the flowering plants, ferns, and conifers native to Europe.	https://data.rbge.org.uk/public/eflora/
South African National Biodiversity Institute (SANBI)	SANBI's PlantZAfrica platform gives data on the flora of southern Africa, including images, distribution maps, and cultural uses.	http://posa.sanbi.org/
Plant databases based on botanical families	**Features**	**URL sites**
The Plant List	A combined state offers a working list of recognized plant species names and words on a global scale.	http://www.theplantlist.org/
Australian Plant Name Index (APNI)	The Australian Plant Name Index (APNI) is an online database that covers all names, whether current names, synonyms or invalid names and all published names of Australian vascular plants.	https://www.anbg.gov.au/cgi-bin/apni
Flora of China	A large asset gives data on the flora of China, including descriptions, illustrations, and distribution maps.	http://www.efloras.org/flora_page.aspx?flora_id=2
Flora of North America (FNA)	The Flora of North America North of Mexico (usually referred to as FNA) is a multiform work describing the native plants and naturalized plants of North America, including the United States, Canada, St. Pierre and Miquelon, and Greenland.	http://www.efloras.org/flora_page.aspx?flora_id=1
JSTOR Global Plants	It provides access to a broad range of botanical resources, including images and taxonomic information.	https://www.jstor.org/plants
Web based plant databases	**Features**	**URL sites**
Plants of the World Online (POWO)	It delivers information on the taxonomy, identification, images, distribution, traits, threat status, molecular phylogenies and uses of vascular plants worldwide.	http://www.plantsoftheworldonline.org/

The Plant List	A combined state offers a working list of recognized plant species names and words on a global scale.	http://www.theplantlist.org/
International Plant Names Index (IPNI)	A database of plant names, allows researchers to place and state data on plant names and their publication details.	https://www.ipni.org/
Flora of North America (FNA)	The Flora of North America North of Mexico (usually referred to as FNA) is a multiform work describing the native plants and naturalized plants of North America, including the United States, Canada, St. Pierre and Miquelon, and Greenland.	http://www.efloras.org/flora_page.aspx?flora_id=1
The Arabidopsis Information Resource (TAIR)	The Arabidopsis Information Resource (TAIR) maintains adatabase of genetic andmolecular biology data for the model higher plant *Arabidopsis thaliana*.	https://www.arabidopsis.org/
Desktop plants database applications	**Features**	**URL sites**
MyHerbarium	A desktop application for succeed herbarium collections, view plant specimen data, images, and related data.	https://www.myherbarium.net/
PGR Studio	A desktop software for ensuing plant genetic resources, gives tools for data entry, analysis, and visualization.	https://pgr-studio.org/
Mobile plant databases applications	**Features**	**URL sites**
PlantSnap	It allows users to mean plants by action pictures of leaves, flowers, or fruits. Give data on recognised plant species.	https://plantsnap.com/
iNaturalist	A community-driven app for recording and mutuality notes of plants and wildlife.	https://www.inaturalist.org/
Flora Incognita:	A plant identification app based on artificial intelligence. It offers data about wild plants, flowers, and trees.	https://floraincognita.com/
PlantNet	It allows users to refer plants by visual recognition and adds a large plant database and community contribution.	https://plantnet.org/en/
Garden Tags	Organized for gardening enthusiasts, this app helps users identify plants and associate with a gardening community.	https://gardentags.com/
Databases that involve contributions from researchers, practitioners, or the general public.		
iNaturalist	A community-driven platform for sharing and identifying notes of plants, animals, and fungi.	https://www.inaturalist.org/
eBird:	A bird observation database where birdwatchers and researchers world change observation.	https://ebird.org/

as a facility of traditional knowledge,international or local scales and facilitate data management and information sharing with other researchers (He *et al*., 2022.such as African Ethnobotany Database (AEDB) (Gras *et al*., 2018), Medicinal Plant Database (MPDB) ("List of tables," 2013).

Clinical plant databases are rich resources that give information about plants with medicinal properties, such as DIMPSAR: Datasets for Indian medicinal plant species analysis (Wu *et al*., 2019), pubmed etc. These databases serve knowledge related to various features of medicinal plants, including their botanical

Table 3: Strengths and weaknesses of databases.

Category based databases	Strengths	Weaknesses
Based on Data Types	• Provide detailed information on the chemical composition of plants, considering identification of bio active compounds. • Valuable resource for researchers interested in drug discovery and development from natural sources. • It has added tools for visualizing chemical structures, aiding researchers in understanding molecular components.	• May lack collection on the biological state or pharmacological effects of identified phyto chemicals. • Some databases might be incomplete or not on a regular basis, leading to gaps in available information. • The detailed chemical data may be consuming for non-specialists or those with limited chemistry prospects.
Based on Geographical Focus Databases:	• It provides information on a wide range of plant species from different regions of the world. • Databases focusing on specific regions may offer more detailed and localized information. • Databases focused on individual countries can provide information about the native and introduced plant species in that specific area.	• It may not be provided detailed or accurate information for specific localities. • Databases focusing only on a single country may not capture the broader context of plant distribution and characteristics.
Based on Plant Families	• It helps users to easily navigate and locate information on related species, facilitating accurate identification and research. • It provides vision into traditional uses, as certain plant families are known for specific medicinal properties. • Chemical • It helps in identifying trends in bio-active compounds, which is crucial for researchers studying the pharmacological properties of plants.	• There is Lack of Data for Some Families of plant in the database. • Comparing medicinal properties across different plant families is difficult in database. • If medicinal plants databases are organized by families are not regularly updated, the database may become outdated, affecting the accuracy of information.
User-Friendly Interface:	• Effective search functionality allows users to input queries and retrieve relevant information efficiently. • A database is optimized for mobile devices and ensures accessibility across a range of platforms. • Give support for multiple languages makes the database accessible to a broader audience. • View interactive tools such as maps, images, or multimedia content can enhance the user experience.	• In a user-friendly interface database, a poorly designed interface with complex navigation can lead to user frustration. • It has lack of search functionality, is limited or lacks advanced features, Performance Issues. • It has a Lack of Consistency in Data Presentation. • It supports Single Language in database search system

names, vernacular names, medicinal uses, and more. Global plant databases are valuable resources that give information about various plant species from around the world, such as The Plant List (Bartow,2016), Global Biodiversity Information Facility (GBIF) (Columbus, 2008) etc. A regional plant database is a collection of information about plants that grow in a specific geographical area. These databases serve various aims, including scientific research, conservation efforts, and understanding the diversity of plant species such as Australian Plant Name Index (APNI) (Sharr, 1996), South African National Biodiversity Institute (SANBI) ("African plant database," 2017). Plant databases based on their botanical families maintain a broad Medicinal Plant Database and provides information on scientific names, family, vernacular names, medicinal uses, species locations, and images of her-barium specimens such as South African National Biodiversity Institute (SANBI) ("African plant database," 2017), The Plant List (Bartow, 2016). Web-based plant databases play an essential role in conserving and sharing knowledge about plant species. allows users to mean plants by action pictures of leaves, flowers, or fruits and give data on recognised plant species such as Plants of the World Online (POWO) ("Southern Africa (Vol 13, 2016)," n.d., The Plant List. (Bartow, 2016) Desktop plants database applications for ensuing plant genetic resources, give tools for data entry, analysis, and visualization. The mobile

Table 4: **Unique features or innovations of database.**

Category based databases	Unique Features/Innovations
Based on Data Types	• It modifies high tools for visible chemical structures of bio-active compounds, assisting researchers in better understanding molecular characteristics. • Utilise of portent models for calculation belongings of petrochemicals, such as bio availability or toxicity, betters the understanding of their potential applications. • It helps to integrate with metabolic data to give a more holistic view of plant chemistry, facilitating researchers to explore interactions between single metabolites.
Databases based on geographical focus	• Incorporating interactive maps helps to explore the distribution of plant species geographically. This feature can provide a visual representation of plant diversity within a specific region. • This includes information on traditional uses of plants by local communities, can offer insights into the cultural significance of plants' traditional medicinal practices.
Based on Plant Families	• It offers detailed information on the chemical composition of plants within a family. It helps to explore the presence of specific phytochemicals, secondary metabolites, and active compounds shared among related species. • By highlighting medicinal uses specific to each plant family, including traditional and contemporary applications. • It provides information on the ecological preferences of plant families, including soil types, climate conditions, and preferred habitats. • It helps in categorizing plant families based on their pharmacological properties and can help researchers in identifying families with specific therapeutic potentials.
User Interface and Accessibility	• Incorporating interactive 3D models of medicinal plants to allow users to explore plant structures in detail. • if it creates Personalized User Dashboards in the database. it helps to customize their dashboards, choosing preferred display elements, such as favorite plant families, recently viewed species, or personalized note. • If it provides virtual tours of medicinal gardens through VR technology, allowing users to explore different plant families and their environments in a virtual space.

plant database application allows users to mean plants by action pictures of leaves, flowers, or fruits. Give data on recognised plant species such as My Herbarium (Conroy and Noon, 1996). Mobile plant databases applications allow users to mean plants by action pictures of leaves, flowers, or fruits. Give data on recognised plant species Organized for gardening enthusiasts, this app helps users identify plants and associate them with a gardening community such as Plant snap (Conroy and Noon, 1996). Table 3 shows the strengths and weaknesses of databases plant databases based on definite features. Table 4 shows the unique features or innovations of the plant databases based on definite features.

Challenges faced according to the current medicinal plant database

After studying a few the medicinal plant databases. Noticed that ethno-pharmacological information in medicinal plant database about medicinal plants are available in some minimal standards in medicinal plant database development. They reported some challenges related to sharing information in developing medical plant databases. Ethnobotanical issues (like lack of benchmark model, intellectual property rights, multiple taxonomies, conservation strategies and bio-piracy) and technical issues (e.g., lack of regular updates, non-disclosure of publishing year, inaccessibility to the website or relocation to other websites, evolution of hardware and software, obsolescence of systems and high cost of system maintenance) are major challenges reputable in this review article.

CONCLUSION

Medicinal plants give the potency to discovering new medicine from nature. Online Medicinal plant databases provide with information about their new approaches, contents. Its help in building is crucial for achieving Medicinal plant databases. This review article shows that every medicinal plant database is different in terms of content and information representation. There are some common standards for creating databases (in terms of information) for different parameters. It helps different classes of users to separate information and establish complex knowledge. This review gives a visual view of the medicinal plant databases. Medicinal plant databases can collect more useful information from different sources (e.g. scientific databases and differentiated databases), approaches (e.g. computational methods) and programs/software (e.g. ChemBioOffice and CMap). All users can easily search, download and visualize these data, as well as the relationships between database components. Medicinal plant databases have been the main source of treatment for different human diseases from aging. Interest in plant-based products gives an idea about the discoveries of modern drugs has grown in recent years. However, research on exploring the medicinal plant database for modern therapeutics is seriously limited due to our incomplete understanding of the therapeutic mechanism of action. Most of the information existing about the use of medicinal plants database in different types of disease treatment and medicine formula in traditional medicine textbooks are based on human experiences, not based on scientific experiments (e.g. Randomized Control Trials). Existing a comprehensive medicinal plant database with various modern biomedical database features could set the way for new plant-based drug discoveries.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

REFERENCES

African plant database. (2017). African Studies Companion Online.h*ttps://doi.org/10.1163/1872-9037_afco_as*c_3143 [Google Scholar]

Agyei-Baffour, P., Kudolo, A., Quansah, D. Y., and Boateng, D. (2017). Integrating herbal medicine into mainstream healthcare in Ghana: Clients' acceptability, perceptions and disclosure of use. BMC Complementary and Alternative Medicine, 17(1).https://doi.org/10.1186/s12906-017-2025-4[Google Scholar]

Apweiler, R. (2004). UniProt: The universal protein knowledgebase. Nucleic Acids Research, 32(90001), 115D-119.https://doi.org/10.1093/nar/gkh131[Google Scholar]

Bartow, A. (2016). Native seed production manual for the Pacific Northwest. Native Plants Journal, 17(2), 134-135.https://doi.org/10.3368/npj.17.2.134 [Google Scholar]

Beer, A., and Ostermann, T. (2003). On the use of classical naturopathy and complementary medicine procedures in hospitals and clinics practicing gynecology and obstetrics in Germany. Gynecologic and Obstetric Investigation, 55(2), 73-81.https://doi.org/10.1159/000070178[Google Scholar]

Bodenreider, O. (2008). Biomedical Ontologies in action: Role in knowledge management, data integration and decision support. Yearbook of Medical Informatics, 17(01), 67-79.https://doi.org/10.1055/s-0038-1638585[Google Scholar]

Boyle, B., Hopkins, N., Lu, Z., Raygoza Garay, J. A., Mozzherin, D., Rees, T., Matasci, N., Narro, M. L., Piel, W. H., Mckay, S. J., Lowry, S., Freeland, C., Peet, R. K., and Enquist, B. J. (2013). The taxonomic name resolution service: An online tool for automated standardization of plant names. BMC Bioinformatics, 14(1), 1-15.https://doi.org/10.1186/1471-2105-14-16[Google Scholar]

Britan, A., Cusin, I., Hinard, V., Mottin, L., Pasche, E., Gobeill, J., Rech de Laval, V., Gleizes, A., Teixeira, D., Michel, P., Ruch, P., and Gaudet, P. (2018). Accelerating annotation of articles via automated approaches: Evaluation of the neXtA5 curation-support tool by neXtProt. Database, 2018.https://doi.org/10.1093/database/bay129[Google Scholar]

Brockdorff, N., and Wei, G. (2021). Faculty opinions recommendation of HERB: A high-throughput experiment- and reference-guided database of traditional Chinese medicine. Faculty Opinions - Post-Publication Peer Review of Biomedical Literature, 49, D1197-d1206.https://doi.org/10.3410/f.739503468.793583410[Google Scholar]

Bultum, L. E., Woyessa, A. M., and Lee, D. (2019). ETM-DB: Integrated thiopian traditional herbal medicine and phytochemicals database.BMC Complementary and Alternative Medicine,19(1), 1-14.https://doi.org/10.1186/s12906-019-2634-1[Google Scholar]

Chen, C. Y. (2011). TCM Database@Taiwan: The world's largest traditional Chinese medicine database for drug screening in Silico. PLoS ONE, 6(1), e15939.https://doi.org/10.1371/journal.pone.0015939{Google Scholar]

Chen, Q., Springer, L., Gohlke, B. O., Goede, A., Dunkel, M., Abel, R., Gallo, K., Preissner, S., Eckert, A., Seshadri, L., and Preissner, R. (2021). SuperTCM: A biocultural database combining biological pathways and historical linguistic data of Chinese materia medica for drug development. Biomedicine and Pharmacotherapy, 144, 112315. https://doi.org/10.1016/j.biopha.2021.112315[Google Scholar]

Columbus, J. T. (2008). Flora of China illustrations. Vol. 22. Poaceae flora of China illustrations. Vol. 22. Poaceae. Zhengyi WU, Peter H raven (editorial committee Co-chairs), Deyuan Hong (editorial committee vice Co-chair). 2007. Science press (Beijing, China) and Missouri botanical garden press (St. Louis, MO). 937 pp. Hardcover. $140.00. ISBN: 978-1-930723-61-0. Madroño, 55(4), 296-296.https://doi.org/10.3120/0024-9637-55.4.296[Google Scholar]

Conroy, M. J., and Noon, B. R. (1996). Mapping of species richness for con*servation of biological diversity: Conceptual* and methodologicaL issues. Ecological Applications, 6(3), 763-773.https://doi.org/10.2307/2269481[Google Scholar]

Conservatoire et Jardin Botaniques Ville de Genève. (2017). African plant database. Retrieved April 1, 2016, fromhttp://www.ville-ge.ch/musinfo/bd/cjb/africa/[Google Scholar]

Danisman, S. (2016). TCP transcription factors at the interface between environmental challenges and the plant's growth responses. Frontiers in Plant Science, 7.https://doi.org/10.3389/fpls.2016.01930[Google Scholar]

Dankar, F. K., Ptitsyn, A., and Dankar, S. K. (2018). The development of large-scale de-identified biomedical databases in the age of genomics—principles and challenges. *Human Genomics, 12(*1).https://doi.org/10.1186/s40246-018-0147-5[Google Scholar]

Degtyarenko, K., De Matos, P., Ennis, M., Hastings, J., Zbinden, M., McNaught, A., Alcantara, R., Darsow, M., Guedj, M., and Ashburner, M. (2007). ChEBI: A database and ontology for chemical entities of biological interest. Nucleic Acids Research, 36(Database), D344-D350.https://doi.org/10.1093/nar/gkm791[Google Scholar]

Dinda, B., and Saha, S. (2022). Obesity and diabetes.Natural Products in Obesity and Diabetes, 1-61.https://doi.org/10.1007/978-3-030-92196-5_1[Google Scholar]

Farsani, L., Latifi, M., Salimi, S., Karami, N., and Dolatabadi, N. (2020). Effective characteristics on designing the information system of medicinal plants from a users' perspective. Journal of Education and Health Promotion, 9(1), 245.https://doi.org/10.4103/jehp.jehp_750_19 [Google Scholar]

Fine, P. V., and Ree, R. H. (2006). Evidence for a time-integrated species-area effect on the latitudinal gradient in tree diversity.The American Naturalist,168 (6), 796-804. doi:10.1086/508635[Google Scholar]

Gaulton, A., Bellis, L. J., Bento, A. P., Chambers, J., Davies, M., Hersey, A., Light, Y., McGlinchey, S., Michalovich, D., Al-Lazikani, B., and Overington, J. P. (2011). ChEMBL: A large-scale bioactivity database for drug discovery. Nucleic Acids Research, 40(D1), D1100-D1107.https://doi.org/10.1093/nar/gkr777[Google Scholar]

Gras, A., Parada, M., Rigat, M., Vallès, J., and Garnatje, T. (2018). Folk medicinal plant mixtures: Establishing a protocol for further studies. Journal of Ethnopharmacology, 214, 244-273.https://doi.org/10.1016/j.jep.2017.12.014 [Google Scholar]

He, S., Yang, L., Ye, S., Lin, Y., Li, X., Wang, Y., Chen, G., Liu, G., Zhao, M., Zhao, X., Wei, K., Zhang, G., Miao, J., Dong, Y., and Yang, S. (2022). MPOD: Applications of integrated multi-omics database for medicinal plants. Plant Biotechnology Journal, 20(5), 797-799.[Google Scholar]

Hussain, N., Chanda, R., Abir, R. A., Mou, M. A., Hasan, M. K., and Ashraf, M. A. (2021). MPDB 2.0: A large-scale and integrated medicinal plant database of Bangladesh. BMC Research Notes, 14(1), 1-6.https://doi.org/10.1186/s13104-021-05721-6[Google Scholar]

Jamal, S., Arora, S., and Scaria, V. (2016). Computational analysis and predictive Cheminformatics modeling of small molecule inhibitors of epigenetic modifiers. PLOS ONE, 11(9), e0083032.https://doi.org/10.1371/journal.pone.0083032[Google Scholar]

Jones, A. C., White, R. J., and Orme, E. R. (2011). Identifying and relating biological concepts in the catalogue of life. Journal of Biomedical Semantics, 2(1), 7.https://doi.org/10.1186/2041-1480-2-7[Google Scholar]

Joos, S., Glassen, K., and Musselmann, B. (2012). Herbal medicine in primary healthcare in Germany: The patient's perspective. Evidence-Based Complementary and Alternative Medicine, 2012, 1-10.https://doi.org/10.1155/2012/294638[Google Scholar]

Kerwin, S. M. (2010). ChemBioOffice ultra 2010 suite. Journal of the American Chemical Society, 132(7), 2466-2467.https://doi.org/10.1021/ja1005306[Google Scholar]

Lagorce, D., Bouslama, L., Becot, J., Miteva, M. A., and Villoutreix, B. O. (2017). FAF-drugs4: Free ADME-tox filtering computations for chemical biology and early stages drug discovery. Bioinformatics, 33(22), 3658-3660.https://doi.org/10.1093/bioinformatics/btx491[Google Scholar]

Li, B., Ma, C., Zhao, X., Hu, Z., Du, T., Xu, X., Wang, Z., and Lin, J. (2018). YaTCM: Yet another traditional Chinese medicine database for drug discovery. Computational and Structural Biotechnology Journal, 16, 600-610.https://doi.org/10.1016/j.csbj.2018.11.002[Google Scholar]

List of tables. (2013). From Plant Genomics to Plant Biotechnology, xv.https://doi.org/10.1016/b978-1-907568-29-9.50016-7[Google Scholar]

Mahmud, S., Paul, G. K., Biswas, S., Kazi, T., Mahbub, S., Mita, M. A., Afrose, S., Islam, A., Ahaduzzaman, S., Hasan, M. R., Shimu, M. S., Promi, M. M., Shehab, M. N., Rahman, E., Sujon, K. M., Alom, M. W., Modak, A., Zaman, S., Uddin, M. S., … Saleh, M. A. (2022). Phytochemdb: A platform for virtual screening and computer-aided drug designing. Database, 2022, 1-14.https://doi.org/10.1093/database/baac002[Google Scholar]

Maran, S., Yeo, W. W., Lim, S. E., and Lai, K. (2022). Plant secondary metabolites for tackling antimicrobial resistance: A pharmacological perspective.Antimicrobial Resistance, 153-173.https://doi.org/10.1007/978-981-16-3120-7_6[Google Scholar]

Meng, F., Tang, Q., Chu, T., Li, X., Lin, Y., Song, X., and Chen, W. (2022). TCMPG: An integrative database for traditional Chinese medicine plant genomes. Horticulture Research, 9, 1-8.https://doi.org/10.1093/hr/uhac060[Google Scholar]

Mohanraj, K., Karthikeyan, B. S., Vivek-Ananth, R. P., Chand, R. P., Aparna, S. R., Mangalapandi, P., and Samal, A. (2018). IMPPAT: A curated database of Indian medicinal plants, Phytochemistry and therapeutics. Scientific Reports, 8(1).https://doi.org/10.1038/s41598-018-22631-z[Google Scholar]

Mumtaz, A., Ashfaq, U. A., Ul Qamar, M. T., Anwar, F., Gulzar, F., Ali, M. A., Saari, N., and Pervez, M. T. (2016). MPD3: A useful medicinal plants database for drug designing. Natural Product Research, 31(11), 1228-1236.https://doi.org/10.1080/14786419.2016.1233409[Google Scholar]

Missouri Botanical Garden (MBG). (2016). Tropicos.org. Retrieved December 7, 2016, fromhttp://www.tropicos.org [Google Scholar]

Naghizadeh, A., Hamzeheian, D., Akbari, S., Mohammadi, F., Otoufat, T., Asgari, S., Zarei, A., Noroozi, S., Nasiri, N., Salamat, M., Karbalaei, R., Mirzaie, M., Rezaeizadeh, H., Karimi, M., and Jafari, M. (2020). UNaProd: A universal natural product database forMateria Medica of Iranian traditional medicine.Evidence-Based Complementary and Alternative Medicine,2020, 1-14.https://doi.org/10.1155/2020/3690781 [Google Scholar]

Narayanan, R., Acharya, R., Mahajon, B., Khanduri, S., and Srikanth, N. (2022). Contributions to research and development by central council for research in ayurvedic sciences (CCRAS): An appraisal. International Journal of Ayurveda Research, 3(2), 86. https://doi.org/10.4103/ijar.ijar_50_22[Google Scholar]

Nguyen-Vo, T., Nguyen, L., Do, N., Nguyen, T., Trinh, K., Cao, H., and Le, L. (2019). Plant metabolite databases: From herbal medicines to modern drug discovery. Journal of Chemical Information and Modeling, 60(3), 1101-1110.https://doi.org/10.1021/acs.jcim.9b00826[Google Scholar]

Ningthoujam, S. S., Talukdar, A. D., Potsangbam, K. S., and Choudhury, M. D. (2012). Challenges in developing medicinal plant databases for sharing ethnopharmacological knowledge. Journal of Ethnopharmacology, 141(1), 9-32. https://doi.org/10.1016/j.jep.2012.02.042[Google Scholar]

O'Boyle, N. M., Banck, M., James, C. A., Morley, C., Vandermeersch, T., and Hutchison, G. R. (2011). undefined. Journal of Cheminformatics, 3(1), 1-14.https://doi.org/10.1186/1758-2946-3-33[Google Scholar]

Pence, H. E., and Williams, A. (2010). ChemSpider: An online chemical information resource. Journal of Chemical Education, 87(11), 1123-1124.https://doi.org/10.1021/ed100697w [Google Scholar]

Rudra, S., Kalra, A., Kumar, A., and Joe, W. (2017). Utilization of alternative systems of medicine as health care services in India: Evidence on AYUSH care from NSS 2014. PLOS ONE, 12(5), e0176916.https://doi.org/10.1371/journal.pone.0176916[Google S cholar]

Rio de Janeiro Botanical Garden. (2016). Brazilian Flora 2020 in construction. Retrieved February 1, 2017, fromhttp://floradobrasil.jbrj.gov.br[Google Scholar]

Sawada, R., Iwata, M., Umezaki, M., Usui, Y., Kobayashi, T., Kubono, T., Hayashi, S., Kadowaki, M., and Yamanishi, Y. (2018). KampoDB, database of predicted targets and functional annotations of natural medicines. Scientific Reports, 8(1).https://doi.org/10.1038/s41598-018-29516-1[Google Scholar]

Shahin, S. M., Jaleel, A., and Alyafei, M. A. (2021). The essential oil-bearing plants in the United Arab Emirates (UAE): An overview. Molecules, 26(21), 6486.https://doi.org/10.3390/molecules26216486[Google Scholar]

Sorokina, M., and Steinbeck, C. (2020). Review on natural products databases: Where to find data in 2020. Journal of Cheminformatics, 12(1), 1-51.https://doi.org/10.1186/s13321-020-00424-9[Google Scholar]

Southern Africa (Vol 13, 2016). (n.d.). Africa Yearbook Online.https://doi.org/10.1163/1872-9037_ayb_ayb2016_com_0043[Google Scholar]

UniProt: A worldwide hub of protein knowledge. (2018). Nucleic Acids Research, 47(D1), D506-D515.https://doi.org/10.1093/nar/gky1049[Google Scholar]

Visser, E. B., and Weideman, M. (2011). An empirical study on website usability elements and how they affect search engine optimisation. SA Journal of Information Management, 13(1), 5292-5296.https://doi.org/10.4102/sajim.v13i1.428[Google Scholar]

Wang, Y., Xiao, J., Suzek, T. O., Zhang, J., Wang, J., and Bryant, S. H. (2009). PubChem: A public information system for analyzing bioactivities of small molecules. N*ucleic Acids R*esearch, 37(Web Server), W623-W63*3.https://doi.org/10.1093/nar/gkp456[Google Scholar*]

WCSP. (2016). World checklist of selected plant families.Facilitated by the Royal Botanic Gardens, Kew. Retrieved December 31, 2016, fromhttp://apps.kew.org/wcsp/qsearch.do [Google Scholar]

Western Australian Herbarium. (1998). FloraBase—The Western Australian Flora. Department of parks and wildlife. Retrieved September 1, 2016, fromhttps://florabase.dpaw.wa.gov.au/ [Google Scholar]

Wu, Y., Zhang, F., Yang, K., Fang, S., Bu, D., L*i, H., Sun, L., Hu, H.,* Gao, K., Wang, W., Zhou, X., Zhao, Y., and Chen, J. (2019). SymMap: An integrative database of traditional Chinese medicine enhanced by symptom mapping. Nucleic Acids Research, 47(D1), D1110D1117.https://doi.org/10.1093/nar/gky1021[Google Scholar]

Zeng, X., Zhang, P., Wang, Y., Qin, C., Chen, S., He, W., Tao, L., Tan, Y., Gao, D., Wang, B., Chen, Z., Chen, W., Jiang, Y. Y., and Chen, Y. Z. (2018). CMAUP: A database of collective molecular activities of useful plants. Nucleic Acids Research, 47(D1), D1118-D1127. https://doi.org/10.1093/nar/gky965[Google Scholar]