

Internet—Implications for the future of phytopharmacological research

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Modern information technologies and world wide communications through the Internet play a significant role in medicinal plant research across the globe. The phenomenal growth in Internet usage is largely due to the success of World Wide Web. Various useful websites and databases on phytopharmacology are already in the "Net" and many more are being added constantly. The future of phytopharmacological research is handling the existing information in proper way. In this review of the Internet, compilation of important websites is expected to stimulate, instruct and update academicians and researchers involved in phytopharmacological research.

Keywords: Internet, Phytopharmacological research

The Internet ("the Net") is a global computer network allowing communication with millions of computer users and access to resources from around the world¹. No matter what type of computer is used for connection to the Internet, a virtually limitless wealth of resources is available for everyday use. The Internet is also a world wide computer network which allows communication with millions of other internet users and use of web resources throughout the world².

Natural products have been a major source of drugs for centuries. With major advances in biotechnological and phytochemical techniques, academic and industrial interest in discovering and developing bioactive natural products has been a growing trend. Medicinal plants are treated as a subject of serious study and undergoing intense research all over the world. The immense surge of scientific interest in natural products as a potential source of drugs has contributed to the development of phytopharmacology research³. However, the present scientific information in intimidating quantities in various forms of database, virtual libraries, journal sites, may often tend to confuse the prospective researcher⁴. Many of the published articles from India are but minor variations of work already done elsewhere and the reason for this unfortunate "revolution of wheel" is that a thorough literature would not have been done before planning of experiments⁵. Ironically the presence of large information may itself make

scientific research elusive. Most academicians and researchers agree that a rational drug discovery can be initiated if the review of existing information can be conducted in a systematic and objective manner⁶. Today the Internet has presented the researcher with more effective tools for a systematic literature search⁷.

Simple as it may seem, acquiring information on the World Wide Web is like seeking a selective fish in the ocean⁸. Beginners in internet search often restrict their search only to search engines like google, yahoo, infoseek and MSN search, which results in a narrow outcome of required information. Compilation was done with a view to address these difficulties of beginners. This article contains web resources simplified even for an amateur. Various articles on internet resources from different fields were previously published^{9,13}. In this article, we have lightened resources related to phytopharmacology and care has been taken to check accuracy of information given. Because of volatile nature of Internet, every day new web page appears and old page disappears, thus no guarantee can be given for URLs is provided below.

List of databases: Medicinal plants and alternative medicine resources

Databases are the collection of citations published in indexed journal articles using storage devices such as online servers, hard disks and compact discs. Online databases enables a precise query and retrieves a particular set of items by matching words to words from the field of citations. A list of online databases and websites related to medicinal plants and alternative medicines in provided in Table I.

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Table 1 — List of databases: Medicinal plants and alternative medicine resources^{14,15}

BIOSIS provides vital sources of information for life scientists.	http://www.biosis.org/
CISCOM Database	http://www.rccm.org.uk/eise.htm
CRISP (Computer Retrieval of Information on Scientific Projects) = Database of federally funded biomedical research projects conducted at universities, hospitals and other research institutions	http://crisp.cit.nih.gov/
Chinese Medicine: Traditional Chinese Medicine Database System	http://www.cintcm.com/index.htm
Dr. Duke's Phytochemical and Ethnobotanical Databases — An Agricultural Research Service from U.S. Department of Agriculture.	http://www.ars-grin.gov/duke/index.html
EMBASE — An international database to citations covering the biomedical, pharmacological and drug literature	http://www.embase.com/
HerbMed™ — A herbal database	http://www.herbmed.org/
HPPD (Herbal Past and Present Database)	http://www.extra.hu/hbock/dbase/index.html
Indian System of Medicine ⁹ — A Gateway for information on Indian Systems of Medicine and Homoeopathy by Department. of ISMH, Ministry of Health and Family Welfare, Government of India; also links the Indian Ayurvedic Pharmacopoeia	http://indianmedicine.nic.in/
The Medicinal and Aromatic Plants Abstracts (MAPA) ⁶ — A bimonthly abstracting journal by National Institute of Science Communication And Information Resources (NISCAIR), provides coverage of the global literature on all aspects of medicinal and aromatic plants. Till date 81,000 abstracts have been published in 24 volumes covering the period from 1979 to 2002. About 54,000 abstracts (from 1988 onwards) are available in database form	Contact Address : The Director, National Institute of Science Communication And Information Resources, Dr K S Krishnan Marg, New Delhi 110012, India email: director@niscair.res.in ; mapa@niscair.res.in Reprints of full text articles can be obtained from Indian Medlars Centre – http://www.uncat.nic.in/ http://www.healthindex.com/MANTISAbout.html
Manual, Alternative and Natural Therapy (MANTIS) Database — (formerly CHIROLARS) A coverage for health care disciplines not significantly represented in the major biomedical databases, references from more than 1,000 journals, with preference given to peer-reviewed journals	
Dialog Corporation	http://library.dialog.com/bluesheets/html/bl0091.html
Health Index	http://www.healthindex.com/
OID Databases	http://www.ovid.com/
MEDLINE Database — is the best interface known as PubMed from the National Library of Medicine, Bethesda, USA	http://www.ncbi.nlm.nih.gov/entrez/
Medicinal and Poisonous Plant Databases	http://www.biologic.uni-hamburg.de/b-online/ibc99/poison/
MICROMEDEX Complementary and Alternative Medicine (CAM) Series — A series of databases covering four areas, viz. herbal medicine and dietary supplements, clinical protocols, patient education, and herbal and dietary supplement toxicology	http://www.micromedex.com/products/healthcare/cam/
NAPRALERT, NATURAL PRODUCTS ALERT ⁴ — from STN International; contains bibliographic and factual data on natural products, including information on the pharmacology, biological activity, taxonomic distribution, ethno-medicine and chemistry of plant, microbial, and animal (including marine) extracts. In addition, the file contains data on the chemistry and pharmacology of secondary metabolites that are derived from natural sources and that have known structure. The NAPRALERT File contains more than 100,000 records from 1950 to the present. Approximately 50% of the file is from systematic survey of the literature from 1975 to the present. The remaining records were obtained by selective retrospective indexing dating back to 1950	http://info.cas.org/ONLINE/DBSS/napralertss.html http://stncasy.cas.org/html/english/login1.html
Patent Database — United States Patent and Trademark Office: A tool to locate registered patents in complementary and alternative medicine	http://www.uspto.gov/patft/index.html

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Table 1 — List of databases: Medicinal plants and alternative medicine resources^{14,15} — (Contd)

PhytoNET — Centre For Complementary Health Studies, University of Exeter: Resource for those involved in the development, manufacture, regulation and surveillance of phytomedicines and herbal drugs, it contains information from the European Scientific Cooperative on Phytotherapy (ESCOP), forms to submit adverse effects of herbal medicines, development of European standards for safe use of phytomedicines	http://www.escop.com/phytonet.htm
Phytotherapies.org — Free service to individuals registering with the site, an Australian company dedicated to ensuring that practitioners are supplied not only with high quality herbal medicine, but also clinically relevant, scientifically validated technical information and Phytomedicine, manufacturer quality herbal extracts for practitioners.	http://www.phytotherapies.org/
Poisonous Plant Database — Center for Food Safety and Applied Nutrition, United states for Food and Drug Administration.	http://vm.cfsan.fda.gov/~djw/readme.html
USDA/ARS — Phytochemical and Ethnobotanical Databases	http://www.ars-grin.gov/duke/ Chemicals and their biological activities in a particular plant http://www.ars-grin.gov/duke/plants.html Chemicals/concentration in a particular plant. http://www.ars-grin.gov/duke/sd.html Chemicals with a specific activity in a particular plant. http://www.ars-grin.gov/duke/plant_lact.html Ethnobotanical uses for one or more plants. http://www.ars-grin.gov/duke/ethnobot.html Plants containing a particular chemical. http://www.ars-grin.gov/duke/highchem.html http://plants.usda.gov/plants/
USDA/NRCS — Plants National Database — Plant's standardized information	
<i>Monographs</i> American Herbal Pharmacopoeia British Herbal Pharmacopoeia	http://herbal-ahp.org/ http://www.exeter.ac.uk/chs/resqual.html
European Scientific Cooperative on Phytomedicines (ESCOP) : publications	http://info.ex.ac.uk/phytonet/pubs.html
German Commission E Monographs	http://www.herbalgram.org/browse.php/comission_e
United States Pharmacopoeia (USP) — Developing botanical monographs	http://www.usp.org/ http://www.usp.org/dietary/availability.htm
World Health Organization — WHO Monographs on Selected Medicinal Plants	http://www.who.org/ http://www.who.int/medicines/library/trm/medicinalplants/m edplantsdoes.html
World Health Organization's Regulatory Situation of Herbal Medicines	http://www.who.int/medicines/library/trm/who-trm-98-1/who-trm-98-1.doc

Forthcoming events, symposiums and global conferences can be obtained from the websites of different societies and organizations given in Table 2. Phytopharmacological research often requires financial assistance and sophisticated instruments facilities like UV, FT-IR, C₁₃ and H₁ NMR and Mass spectroscopy to elucidate the active compound responsible for pharmacological actions. A list of different organizations (Indian Govt) providing funds, projects and instrument facilities are given in Table 3. An online downloadable article of individual journals in the form of PDF are available on internet makes readers more efficient and also allows viewing archives of journal. List of some URL address of

journals related to phytopharmacology is given in Table 4. List of industries involved in formulation of herbal products is listed in Table 5. Botanical images and its taxonomical details of medicinal plants can be obtained from the websites given in Table 6.

Internet phytopharmacognosy course— The World's first Internet course (only available) on phytopharmacognosy over the Internet was started by Dr John Wilkinson. The course topics include botany, plant identification, microscopy, basic chemistry, phytochemistry, introduction to the pharmacology of herbal constituents (whole extracts as well as isolate chemicals), introduction to analysis and quality control of herbal products, research into herbal

Table 2 — List of organizations and societies related to phytopharmacology^{14,15}

Phytochemical Society of Europe	http://www.DMU.AC.UK/ln/pse/
The American Society of Pharmacognosy	http://www.phcog.org/
International Society for Ethnopharmacology	http://www.dfh.dk/staff/private/ulny/ISE/
European Weed Research Society	http://www.res.bbsrc.ac.uk/ewrs/
International Organization for Plant Information	http://iopi.csu.edu.au/iopi/
The Phytochemical Society of Europe	http://www.dmu.ac.uk/ln/pse/
Phytochemical Society of North America	http://www.fiu.edu/orgs/psna/
Polish Phytochemical Society	http://www.iung.pulawy.pl/ptfc/
European Society of Ethnopharmacology	http://ethnopharma.multimania.com/
Society for Ethnomedicine	http://www.med.uni-muenchen.de/medpsy/ethno/
European Scientific Co-operative on Phytotherapy	http://www.exeter.ac.uk/phytonet/escop.html
Gesellschaft für Arzneipflanzenforschung (Society for Medicinal Plant Research)	http://www.uni-duesseldorf.de/WWW/GA/
International Society of Ethnobiology	http://guallart.dac.uga.edu/ISE/
International Society for Ethnology and Folklore (SIEF)	http://www2.hu-berlin.de/sief/
Centre for Economic Botany (CEB)	http://www.rbgekew.org.uk/scihort/eblinks/
Soci�t� Fran�aise d'Ethnopharmacologie (Society of Ethnopharmacology, France)	http://perso.wanadoo.fr/sfe-sec/
Society of Ethnobiology	http://ethnobiology.org/
The Society for Economic Botany	http://www.econbot.org/
American Society of Plant Biologists	http://www.aspb.org/
Boyce Thompson Institute for Plant Research	http://bti.cornell.edu/
International Council for Medicinal and Aromatic Plants	http://www.icmap.org/
Medicinal and Aromatic Plant and Drug Research Centre (TBAM) of Anadolu University in Eskisehir, Turkey	http://www.tbam.anadolu.edu.tr/index.html
Pharmazeutische Biologie in Deutschland (Pharmaceutical Biology in Germany)	http://www.rz.uni-duesseldorf.de/WWW/MathNat/PharmBio/liphabio.htm
Herb Research Foundation	http://www.herbs.org/

Table 3 — Government organizations involved in medicinal plant research (India)¹⁴

CSIR — Council for Scientific and Industrial Research (Funding Agency)	http://www.emmaes.ernet.in/nal/icsi/csirh.html
Indian Council of Medical Research (ICMR) (Funding Agency)	http://www.icmr.nic.in/
CCMB — Centre for Cellular & Molecular Biology, Hyderabad	http://www.ccmbindia.org/
Central Council of Research and Ayurvedic System	http://ccras.org/bibliography/klist.htm
CDRI — Central Drug Research Institute, Lucknow	http://www.cdriindia.org/
CFTRI — Central Food Technological Research Institute, Mysore	http://www.cftri.com
CIMAP — Central Institute of Medicinal & Aromatic Plants, Lucknow	http://www.cimap.res.in/
IICB — Indian Institute of Chemical Biology, Calcutta	http://www.iicb.res.in/
IICT — Indian Institute of Chemical Technology, Hyderabad	http://www.emmaes.ernet.in/iict/
IISc — Indian Institute of Science	http://iisc.ernet.in
Indira Gandhi Institute of Development Research	http://igidr.ac.in
Jawaharlal Nehru Centre for Advanced Scientific Research	http://jncasr.ac.in
National Academy of Agricultural Science	http://www.naas.edu
National Botanical Research Institute	http://www.nbri-lko.org/R&D.htm
National Institute of Ayurveda Research	http://niar.com/corp-web/index.htm
NIPER — National Institute of Pharmaceutical Education and Research	http://www.niper.nic.in/
Tata Institute of Fundamental Research	http://tifr.res.in

Libraries and Document retrieval centers:

NISCAIR	http://www.niscair.res.in/
Union Catalogue of Biomedical Serials	http://uncat.nic.in/
MEDLARS CENTRE	http://indmed.nic.in/

Sophisticated Instruments facilities in India

Regional Sophisticated instruments facilities in India	http://dst.gov.in/seprog/infra/rsic.htm
RSIC, IIT, Powai, Mumbai	http://www.rsic.iitb.ernet.in
RSIC, IIT, Chennai	http://www.rsic.iitm.ernet.in

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Table 3 — Government organizations involved in medicinal plant research (India)¹⁴ — (Contd)

RSIC, CDRI, Lucknow	http://www.cdriindia.org/
SICART, Gujarat	http://www.sicart.ac.in/
Spice Science Foundation	http://www.spicescience.org/
SIF, IISc., Bangalore	http://sif.iisc.ernet.in

Table 4 — Journals related to phytopharmacology^{14,15}

Current science	http://www.ias.ac.in/currsci/index.html
Chemistry of Natural Compounds	http://www.wkap.nl/journalhome.htm/0009-3130
Fitoterapia	http://www.indena.it/fitotrp.htm
European Journal of Herbal Medicine (NIMH)	http://guest.btinternet.com/~nimh/frameacc.html
History of Traditional Indian Medicine	http://www.mic.ki.se/India.html
Indian Drugs	http://www.idma.org
Indian Journal of Experimental Biology	http://www.niscair.res.in
Indian Journal of Pharmacology	http://www.ijp-online.com
Journal of Agricultural and Food Chemistry	http://www.pubs.acs.org/journals/jafca/
Journal of Asian Natural Products Research	http://www.gbhap.com/journals/419/419-top.htm
Journal of Ethnopharmacology	http://www.elsevier.com/locate/jethpharm
Journal of Herbal Pharmacotherapy	http://www.haworthpressinc.com/store/Default.asp
Journal of Natural Products	http://pubs.acs.org/journals/jnprdf/index.html
Journal of Natural Remedies	http://www.jnronline.com
Journal of Pharmacy and Pharmacology	http://jpp.pharmpress.com/content/html/
Medicinal and Plant Abstracts	http://www.niscom.res.in/
Natural Products Report	http://www.rsc.org/is/journals/current/npr/nprpub.htm
Natural Product Letters	http://www.gbhap-us.com/journals/724/724-top.htm
Planta Medica	http://www.thieme.com/chemistry/aec.htm
Plant Science (Elsevier)	http://www.elsevier.com/inca/publications/store/5/0/6/0/3/0/
Pharmaceutical Biology	http://www.swets.nl/sps/journals/pb.html
Phytochemistry	http://www.elsevier.nl/inca/publications/store/2/7/3/index.htm
Phytochemical Analysis (Wiley)	http://www.interscience.wiley.com/jpages/0958-0344/info.html
Phytomedicine	http://www.urbanfischer.de/journals/phytomed/phytmed.htm
Phytotherapy Research	http://www.interscience.wiley.com/jpages/0951-418X/
Review of Aromatic and Medical Plants	http://www.cabi.org/publishing/Products/JOURNALS/Abstract/RAMP/Index.asp
Toxicon	http://www.elsevier.com/inca/publications/store/2/5/9/
Xenobiotica	http://www.tandf.co.uk/journals/tf/00498254.html

List of Discussion Groups

PhytoNET mail-base	http://www.exeter.ac.uk/phytonet/
Phytopharmacognosy	http://www.mailbase.ac.uk/lists/phytopharmacognosy/join.html
Phytopharmacognosy Internet Discussion Group	http://www.phytochemistry.freeserve.co.uk/
The GardenWeb Forums	http://forums.gardenweb.com/forums/

Table 5 — Indian industries involved in manufacturing herbal formulations

Atra Pharmaceuticals	http://www.atrapharma.com
Cipex	http://www.cipex.com/
Dabur India Ltd	http://www.dabur.com/
Gufic Healthcare	http://www.gufic.com/
Fem Care Pharma	http://www.indiafemcare.com/
Kerala Ayurveda Pharmacy	http://www.kapl-ayur.com/html/k0000hom.htm
Hamdard (WAKF)	http://www.hamdard.com/
Sami Labs	http://www.samilabs.com/
Himalaya Drug Co	http://www.himalayahealthcare.com/index.htm
Ranbaxy Ltd	http://www.ranbaxy.com
Sears Phytochem	http://www.searsphytochem.com/
Shree Baidyanath Ayurved Bhawan	http://www.baidyanath.com/

Table 6 — List of websites for botanical images^{14,15}

Australian National Botanical Garden	http://155.187.10.12/images/photo_cd/
Botanical Image Database	http://www.helsinki.fi/kmus/botpics.html
CalPhotos: California Plants & Habitats	http://elib.cs.berkeley.edu/photos/flora/
Color Illustrations of plants	http://chili.rt66.com/hrbmoore/Images/Walcott.html
Color Illustrations from the National Geographic Society	http://chili.rt66.com/hrbmoore/NGSImages/NGS.html
European wild plant photos	http://www.gagg.mcmail.com/Flora.htm
Flora of Europe	http://utopia.knoware.nl/users/aart/index.html
Index of plant pictures by genus and species	http://chili.rt66.com/hrbmoore/HOMEPAGE/GenusIndex.html
Kohler's Medicinal Plants	http://www.mobot.org/MOBOT/research/library/kohler/taxa.html
Medicinal Herbs by Common Name (UW)	http://www.nlm.nih.gov/pnr/uwmhg/comnames.html
Medicinal Plant Photographs by genus	http://chili.rt66.com/hrbmoore/Images/JPEGS.html
PharmaCD - Family Index	http://pharma-apv.unizh.ch/CD-ROM/Familien/Familien.html
Poisonous plants	http://www.ansci.cornell.edu/plants/plants.html
Stein's Virtual Herbarium	http://filebox.vt.edu/forestry/wildlife/stein/plants.html
Vascular Plant Image Gallery	http://www.csdl.tamu.edu/FLORA/gallery/gallery_query.htm

phytochemistry including literature search, and the theory behind lab techniques (HPLC, TLC, extraction, etc.). For more details contact Dr John Wilkinson, Senior Lecturer in Pharmacognosy and Phytochemistry, School of Health, Environmental and Biological Sciences, Middlesex University Enfield, Middlesex EN3 4SF United Kingdom. E mail: JW1@fsmail.net.

Conclusion

Internet is a rich source of information that can be used for advancement in medicinal plant research. Identifying new class of drugs from natural sources has challenged the pharmaceutical industry, the promise of phytopharmacological research to accelerate to the pace of discovering newer therapeutics has not been realized. The widespread availability of information will enable researchers to break barriers that currently limits drug discovery. Immediate access to all scientific literatures has long been a dream of the researcher; the web search engines have made the large and growing body of scientific literature and other information resources accessible within seconds. Today the Internet has presented the researcher with more effective tools for systematic literature search, this article will ease in handling of existing information. In developing countries like India, much of the access to future online environments will be cheaper and broad bandwidth through optic fibre cable networks. Computer literacy and Internet usage should become an integral component of phytopharmacological education, as it plays an important role in drug discovery process.

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