EJB Electronic Journal of Biotechnology ISSN: 0717-3458 Vol.2 No.2, Issue of August 15, 1999.

Invited review paper/ Received April 26, 1999.

REVIEW ARTICLE

Medicinal plants: a re-emerging health aid

Lucy Hoareau
Assistant Programme Officer, Division of Life Sciences UNESCO
1 Rue Miollis, Paris, France 75015
E-mail : l.hoareau@unesco.org

Edgar J. DaSilva *
Director, Division of Life Sciences UNESCO
1 Rue Miollis, Paris, France 75015
E-mail : e.dasilva@unesco.org

Interest in medicinal plants as a re-emerging health aid has been fuelled by the rising costs of prescription drugs in the maintenance of personal health and well-being, and the bioprospecting of new plant-derived drugs. Several issues as well as a range of interests and activities in a number of countries are dealt with. Based on current research and financial investments, medicinal plants will, seemingly, continue to play an important role as an health aid.

Medicinal plants, since times immemorial, have been used in virtually all cultures as a source of medicine. The widespread use of herbal remedies and healthcare preparations, as those described in ancient texts such as the Vedas and the Bible, and obtained from commonly used traditional herbs and medicinal plants, has been traced to the occurrence of natural products with medicinal properties.

The use of traditional medicine and medicinal plants in most developing countries, as a normative basis for the maintenance of good health, has been widely observed (UNESCO, 1996). Furthermore, an increasing reliance on the use of medicinal plants in the industrialised societies has been traced to the extraction and development of several drugs and chemotherapeutics from these plants as well as from traditionally used rural herbal remedies (UNESCO, 1998). Moreover, in these societies, herbal remedies have become more popular in the treatment of minor ailments, and also on account of the increasing costs of personal health maintenance. Indeed, the market and public demand has been so great that there is a great risk that many medicinal plants today, face either extinction or loss of genetic diversity.

Background

Medicine, in several developing countries, using local traditions and beliefs, is still the mainstay of health care. As defined by WHO, health is a state of complete physical, mental, and social well being and not merely the absence of disease or infirmity.

The practise of traditional medicine is widespread in China, India, Japan, Pakistan, Sri Lanka and Thailand. In China about 40% of the total medicinal consumption is attributed to traditional tribal medicines. In Thailand, herbal medicines make use of legumes encountered in the *Caesalpiniaceae*, the *Fabaceae*, and the *Mimosaceae*. In the mid-90s, it is estimated that receipts of more than US$2.5 billion have resulted from the sales of herbal medicines. And, in Japan, herbal medicinal preparations are more in demand than mainstream pharmaceutical products.

Africa is a rich source of medicinal plants. Perhaps, the best known species is *Phytolacca dodecandra*. Extracts of the plant, commonly known as end, are used as an effective molluscicide to control schistosomiasis (Lemma, 1991). Other notable examples are *Catharanthus roseus*, which yields anti-tumour agents such as vinblastine and vinvristine; and *Ricinus communis*, which yields the laxative--castor oil. In Botswana, Lesotho, Namibia and South Africa, *Harpagophytum procumbens* is produced as a crude drug for export. Similarly, *Hibiscus sabdariffa* is exported from Sudan and Egypt. Other exports are *Pausinystalia yohimbe* from Cameroon, Nigeria and Rwanda, which yields *yohimbine*; and *Rauwolfia vomitoria*, from Madagascar, Mozambique and Zaire, which is exploited to yield reserpine and ajmaline.

The use of medicinal plants like *Eupatorium perfoliatum* (bonest), *Podophyllum peltatum* (mayapple), and *Panax quinquefolium* (ginseng) in the USA has long been associated with the American Indians. These plants have also been appreciated and recognised for their aesthetic and ornamental value. In Central America medicinal plants have been widely used - by the *Maya* Indians in Mexico, the *Miskitos* and *Sumus* in Honduras and Nicaragua, the *Pech*, *Lencas*, and *Xicaques* in Honduras, the *Pipiles* in El

* Corresponding author

Salvador, the *Talamancas* in Costa Rica, and the *Guaymis* and *Kunas* in Panama.

In Europe, some 1500 species of medicinal and aromatic plants are widely used in Albania, Bulgaria, Croatia, France, Germany, Hungary, Poland, Spain, Turkey, and the United Kingdom. The Maltese islands constitute an apt example where medicinal plants are widely used in every day life as part of folk medicinal remedies (Lanfranco, 1992).

Issues

Traditional and folklore medicine bequeathed from generation to generation is rich in domestic recipes and communal practice. Encompassing concepts and methods for the protection and restoration of health, traditional medicine has served as a fount of alternative medicine, new pharmaceuticals, and healthcare products. The best known examples of traditional medicine, differing in concept and protocol, are well-developed systems such as acupuncture and ayurvedic medicine that have been widely used to conserve human health in China and India.

Developed countries, in recent times, are turning to the use of traditional medicinal systems that involve the use of herbal drugs and remedies. About 1400 herbal preparations are used widely, according to a recent survey in Member States of the European Union. Herbal preparations are popular and are of significance in primary healthcare in Belgium, France, Germany and the Netherlands. Such popularity of healthcare plant-derived products has been traced to their increasing acceptance and use in the cosmetic industry as well as to increasing public costs in the daily maintenance of personal health and well being. Examples of such beauty-oriented therapeuticals are skin tissue regenerators, anti-wrinkling agents and anti-age creams. Most dermaceuticals are derived from algal extracts that are rich in minerals and the vitamin B group. Skincare products such as skin creams, skin tonics, etc. derived from medicinal plants are grouped together as dermaceuticals. Also, amongst the poor, cures and drugs, derived from plants, constitute the main source of healthcare products.

Gorman (1992) drew attention to the power of Chinese folk medicinal potions in treating maladies from eczema and malaria to respiratory disorders. In the quest for new medicines to treat old and emergent diseases such as malaria and AIDS, attention is now being given to discovering the active ingredients encountered in the treasury of over 5,000 Chinese herbs, plants and roots that have been used routinely and traditionally. *Quinghaosu* and *Chaihu* are two such examples. Whereas the former, called *artemisinin* and obtained from *Artemisia annua* is expected to yield, in the coming millennium, a potent new class of antimalarials, the latter, obtained from *Bupleurum chinense* and used as a popular remedy for hepatitis is the focus of intense research by the Japanese pharmaceutical industry. More recently, the biochemistry of *tianhuafen* or cucumber is being studied in the USA to decipher the identity of *compound Q*, an extract used in China and credited with remedial and relief properties in AIDS sufferers.

Medicinal plants are an integral component of ethnoveterinary medicine. Farmers and pastoralists in several countries use medicinal plants in the maintenance and conservation of the healthcare of livestock. Intestinal disorders in cows, in Mexico, are treated with herbal extracts of *Polakowskia tacacco*. Dietary supplements such as vitamin A in poultry feeds in Uganda are supplied through enrichments of amaranth (*Amaranthus sp.*). It is estimated that medicinal plants, for several centuries, have been widely used as a primary source of prevention and control of livestock diseases. In fact, interest of such use in the veterinary sector has resulted primarily from the increasing cost of livestock maintenance and the introduction of new technology in the production of veterinary medicines and vaccines.

McGee (1998), surveying the use of spice and their medicinal properties around the world, concluded that spices serve the adaptive purpose of reducing food-borne disease. In reviewing relevant texts ranging from the preservative properties of spices against food spoilage to the presence of antimicrobial substances that lay claim to the elimination of pathogenic organisms in food preparations, the case is made for a more objective analysis and study of the medicinal properties of spices *in victu* rather than *in victo*. A whole range of plant-derived dietary supplements, phytochemicals and pro-vitamins that assist in maintaining good health and combating disease are now being described as functional foods, nutriceuticals and nutraceuticals. Table 1 provides some examples of national activities concerning medicinal plants in several developed and developing countries.

Table 1.Examples of national activities concerning medicinal plants

COUNTRY	ACTIVITIES	REMARKS
Afghanistan	• Need for conservation of several medicinal plants e.g. *Ferula foetida, Scorodosma foetida, etc.* endangered by war-stricken	• Potential market remains underdeveloped.

	conditions	
Armenia	• Rich history of use and export of medicinal plants	• Over 3200 species described and conserved for use and export.
Australia	• Asian-Australian Centre for the Study of Bioactive Medicinal Plant Constituents was set up in 1992 at La Trobe University for conduction of research in collaboration with Chulalongkorn and Chieng-Mai Universities in Thailand	• Inter-university research work focuses on: - The bioactive constituents of turmeric e.g. *curcumin* - Islamic medicinal plants - Antifungal proteins and secondary metabolites in crop plants, e.g. in cotton and yellow mustard *Sinapis alba* - Marine toxins -Collaboration on medicinal plants with scientists from Indonesia, Thailand, Bangladesh, Singapore, Kuwait and New Zealand.
Bangladesh	• Research on cultivation and biochemical aspects of medicinal plants	• Bangladesh Council for Scientific and Industrial Laboratory at Chittagong oversees development of appropriate chemical technologies, and pharmacopoeia of plants.
Bhutan	• Sustainable protection and use of forest resources and development of plant tissue culture	• Capacity building in plant biotechnology for rural markets and development of forest seedlings Indigenous Hospital in Thimphu has recorded 180 species of medicinal and aromatic plants
Canada	• Southern Crop and Food Production Centre of Agriculture and Agrifood Canada mandated to develop novel technologies in production and protection of new crops inclusive of medicinal plants	• Active research on crop production, genetics, germplasm improvement, micropropagation, and protection of medicinal herbs. Attention is given to research in developing base-line agronomic information, elucidating the chemistry of bioactive principles, etc.
China astralgus	• Chinese root extracts from *Astragalus membranaceus* have been developed for use as a general tonic food and for boosting immunity • Institute of Medicinal Plants established in 1983 with branches in provinces of Yunnan, Hainan and Guangxi	• Used in Chinese herbal medicine to strengthen the vital energy *Qi* in general health and well being • Product widely used in China, and South Asia • Work deals with the development, conservation and utilisation of medicinal plant resources, and the discovery of new potent drugs. The Institute is also recognised as a WHO Collaborating Centre on Traditional Medicine
	• Hong Kong Society for Traditional Medicine and Natural Products Research	• Established in 1995, activities focus on research, training and public education in traditional medicine and natural products. Professional services available for commercial, government and industrial sectors.
Dominican Republic	• Launched in 1982 as a traditional medicine for the islands (TRAMIL) network with support	• Regional node was established in Panama in 1994 to cover area from Belize to Panama. Over 150 medicinal plants evaluated and results disseminated in *Caribbean Pharmacopoeia*. TRAMIL widely recognised in Dominican Republic, Honduras,

	from IDRC, activities focus on developing scientific proven medicinal plant remedies as alternatives to patent drugs that are expensive and difficult to obtain in rural populations	Nicaragua and Panama as effective mechanism in devising primary healthcare programmes.
Estonia	• Network of plant genetic resources inclusive of medicinal plants	• Development of computerised genebank system at Jogeva Plant Breeding Institute linking inputs from the Polli Horticultural Institute and the Estonian Agricultural University and Botanical Garden.
Guatemala	• *Farmaya* Laboratory, following screening of 700 different plants, has developed 15 pharmaceutical products using traditional knowledge of indigenous and rural groups; *Farmaya* engaged in organic cultivation of medicinal plants, pharmacological research, production of plant-derived pharmaceuticals, and engaged in developing protocols for the safe use of medicinal plants	• Collaborates with the Central America Centre of Studies on Appropriate Technologies (CEMAT) • Created a National Commission for the Use of Medicinal Plants which serves as a model for other Latin American countries in developing guidelines and standardised protocols for production of plant-based pharmaceuticals • Co-operates in the IDRC project on the *Application, Research and Dissemination of the Use of Medicinal Plants in the Caribbean.*
India	• Governmental programme launched in 1993 for implementation by an NGO called "Foundation for Revitalisation of Local Health Traditions"	• 30 *in situ* "Medicinal Plant Conservation Areas" (MPCA), 15 *ex situ* "Medicinal Plant Conservation Parks (MPCP), and one Model Production Unit (MPU) have been established in the programme, for large-scale production in Karnataka, Tamil Nadu and Kerala.
	• Herbal Gene Bank at the Tropical Botanic Garden Research Institute at Thiruvananthapurnam	• All-India ethnobiological project for the development of drugs from medicinal plants and herbs. Promotion of ethnopharmacological research
	• Central Institute of Medicinal and Aromatic plants in Lucknow	• Institute deals with plant tissue culture of medicinal plants of commercial significance; monitors All-India Co-ordinated project on Conservation of Endangered Plant species; maintenance of living herbaria or plant gardens that feed traditional systems of medicine such as Ayurveda, Unani and Sidha. Ayurveda recognised by WHO as an alternate system of medicine.
	• Germplasm Bank, Point Calimere Wildlife Sanctuary Tamil Nadu	• More than 40 species of medicinal plants are maintained and protected. Examples are *Manilkara hexandra* to treat jaundice, *Salvadora persicum* to treat ulcers; *Mucuma purata* used for preparation of a health tonic.

Japan	• Tsukuba Medicinal Plant Research Station focuses on plant cultivation breeding and conservation methods of medicinal plants; and research on the development of bioactive components	• Affiliate of the National Institute of Health Sciences, this Medicinal Plant Research Station maintains an exchange programme with about 400 research programmes in over 60 countries. • Medicinal plants such as *Duboisia, Scopolia, Curcuma, Salvia* and *Zingiber are maintained in tissue cultures*
	• Research Centre of Medicinal Resources Medicinal Plant Gardens, Chiba University	• Chemical, biochemical and pharmacological studies on plant secondary metabolites. • Pharmacological studies of neurotoxic proteins in *Lathyrus sativus.* • Screening for biologically active products in Asian medicinal plants.
Kazakhstan	• Conservation of crop germplasm (wheat, barley, maize, rye, medicinal plants)	• Development of national programme to increase drought, disease and frost-resistance of plants of economic significance.
Korea, Republic of	• Natural Products Research Institute	• Has played, for over 50 years, leading role in research of natural drugs in Korea. Designated in 1977/1978 as *Headquarter Centre for UNESCO Regional Network for the Chemistry of Natural products in Southeast Asia*, and in 1988 as *WHO Collaborating Centre for Traditional Medicine*. In 1997, the Institute was appointed as the *Korea-China Collaborating Centre for Traditional Oriental Medicines Research*
Latvia	• National Network of plant genetic resources inclusive of medicinal plants	• Development of computerised database at the Institute of Biology of the Latvian Academy of Sciences pooling inputs from 8 different Latvian institutions
Lithuania	• Network of plant genetic resources	• Lithuanian Institute of Agriculture co-ordinates collection of agricultural crops, hops and medicinal plants in Kaunas Botanical Garden, herbs in the Botanical Institute in Vilnius, and industrial plants in the Horticultural Institute on Babtai.
Malaysia	• Malaysia Natural Products Society formed in 1994 overseeing co-ordination of activities with medicinal plants and eventual release of *Malaysian Pharmacopoeia*	• Screening of marine and terrestrial biochemical diversity for medicinal principles, phytomedicinals and nutraceuticals • Active partners are: Universiti Kebangsaan Malaysia; Universiti Pertanian Malaysia; Universiti Teknologi Malaysia; Universiti Sains Malaysia; Universiti Malaysia Sarawak and the Forest Research Institute of Malaysia, which are pioneering research into the isolation, screening and crystallisation of bioactive compounds and phytomedicinals from e.g. *Mitragyna speciosa*, *Alstonia anguslifolia*, and *Dehaasia incrassata* that have been used in traditional medicine.
Malta	• Medicinal plants are widely used as part of folk medicinal remedies. Well-known Maltese examples are: *fejgel*, *faqqus il-hmir*, and *hobbeja.*	• Need for conservation since land exploitation and recovery is destroying natural habitats.
Moldova	• Crop improvement and seed distribution	• Development of disease, pest, and environmental-stress resistant of oil-bearing and medicinal plants.

	programmes	
Mongolia	• Inventorization and classification of more than 450 medicinal and nutritional herbs	• Institute of Botany, Mongolian Academy of Sciences. Research results reveal more than 30 new flowers.
Myanmar	• Conservation of plant genetic resources and medicinal plants	• Research programmes at Yangon (formerly Rangoon) University focus on folk medicinal herbs; pharmacognostic studies; and bioassay of plants credited with anti-tumour, anti-pyretic and anti-diabetic properties.
Nepal	• Plant biotechnology, mushroom cultivation, bioenergy production, environmental microbiology and medicinal plants	• University programmes in plant tissue culture, and environmental microbial-based technologies; medicinal plants widely cultivated in Shivpuri, Doti, Tistung, Urindavan and Tarakava Herbal farms. Herbal products widely marketed as Ayurvedic therapeutics.
New Zealand	• Conservation of medicinal plants used in Maori medicine	• *Coprosma robusta* – a sacred Maori medicinal plant, and *Aristotelia serrata* used by early settlers maintained in nurseries.
Nigeria	• Preservation of Nigerian genetic patrimony comprised of 5000 acquisitions of edible, fodder, forest, industrial and medicinal plants	• Research supported by National Centre for Genetic Resources and Biotechnology which functions also as affiliate of International Centre for Genetic Engineering and Biotechnology.
Norway	• Collaborative project between UNESCO and Governmental agency	• Conduction of research work in the origins, uses, trades, and constraints in the cultivation of medicinal plants in Mozambique and Madagascar by students at M.Sc. level.
Pacific Islands	• *Noni*, a Tahitian herbal tonic derived from *Morinda citrifolia* is used as a general tonic food and energiser	• Product widely used in China and South Asia and widely marketed throughout the pacific islands.
Peru	• Non-governmental organisation *Consejo Aguaruna y Huambisa* comprised of 30,000 members harvesting and supplying plant material on sustainable basis	• Cooperates with *Shaman Pharmaceuticals* in ensuring employment and income for indigenous populations in Africa, Asia and Latin America. • Cooperation focuses on protection of biological and cultural diversity.
Russia	• Medicinal Plants reared and protected as economic bioresource in Karadag Reserve	• Karadag Reserve serves as a base for studying the bioecological properties for Crimean medicinal plants such as *Rosa canina.*

South Africa	• A traditional medicines programme (TRAMED) was started in 1994 at the University of Cape Town to promote the cultural, health, environmental, scientific and socio-economic benefits to be obtained from the development, conservation and sustainable use of east and southern Africa's medicinal plants	• Integral part of *WHO collaborating Centre for Drug Policy* based in the University of Cape Town and the University of the Western Cape.
	• Collaborating partners are: - University of Durban-Westville, Durban - Kenya Medical Research Institute, Nairobi, Kenya - WHO Collaborating Centre for Adverse Drug Event Monitoring, Uppsala, Sweden - Royal Botanic Gardens, Kew, U.K.	• TRAMED activities focus on - Development of database for east and southern Africa - Laboratory screening of traditional medicines in malaria and tuberculosis - Development of eastern and southern Africa network as first step in evolution of an All-Africa network of traditional medicines - Inventorization of indigenous rural and tribal knowledge of traditional medicines - Articulation of national policy for the conservation, control, regulation and use of traditional medicines in South Africa.
Sri Lanka	• General biotechnologies, medicinal plants	• Possesses rich history of medicinal plants intricately linked with religious and cultural practices. Ayurvedic system of medicine is widespread.
Suriname	• Suriname Bioprospecting Initiative	• In co-operation with governmental authorities development of - pharmaceutical industry in Suriname catalysed by collaboration with US pharmaceutical industry - economic incentives for conservation of biodiversity of medicinal plants - compensation protocols for acquisition of tribal knowledge and medicinal recipes.
Thailand	• Laboratory of Natural Products – research on medicinal plants	• Species been investigated are: Look Tai Bai (*Phyllanthus amarus*), Chai aim Thai (*Derris escalata*, and *Carophyllum inophyllum*). • Based at the Chulabhorn Research Institute, research activities deal with the preparation of dietary supplements and therapeutics from traditional medicinal plants.

Turkey	• Medicinal and Aromatic Plant and Drug Research Centre	• Established in 1982 at Anadolu University, Es Kisehir, the centre is engaged in: • UNIDO/Turkey project on Production of Pharmaceutical Materials from Medicinal and Aromatic Plants • In the preparation of pharmaceuticals, perfumes, cosmetics, dyes, etc. • In the preparation of surveys concerning the assessment of phytochemical and phytopharmaceutical units.
USA	• *Shaman Pharmaceuticals*, based in the San Francisco uses ethnobotany as foundation of drug development process • Conduct studies on epidemiology, traditional medicine, culture and ecology of the region and its environment	• Active in 30 countries.
	• National Germplasm Resources Laboratory of the US Department of Agriculture hosts *PHYTOCHEMECO*, a phytochemical/geographic database	• Contains unique blend of phytochemicals taxonomic, ecological, geographic and climatic aspects - phytochemical database contains data on over 16,000 chemical compounds present in some 16,000 plants of economic importance, and of some 1500 specific activities of some 4,000 plant-derived chemicals - taxonomic database contains plant names of over 8,000 taxa - ecological database contains growing locations of some 6,000 taxa - yield database contains crop yields of some 239 taxa - geographical/climatic database holds data on some 18,000 worldwide locations (with details on latitude, longitude, elevation, soil type, rainfall, temperature and life zones.

Despite the increasing use of medicinal plants, their future, seemingly, is being threatened by complacency concerning their conservation. Reserves of herbs and stocks of medicinal plants in developing countries are diminishing and in danger of extinction as a result of growing trade demands for cheaper healthcare products and new plant-based therapeutic markets in preference to more expensive target-specific drugs and biopharmaceuticals. Such concerns have stimulated positive legal and economic interest.

Issues concerning intellectual property rights, compensation for loss of finance-rich biodiversity resources, and the acquisition and safeguarding of traditional healthcare knowledge are no longer neglected. Bioprospecting of new drugs from medicinal plants and the exploitation of unprotected traditional knowledge in starting-up potentially new bioindustries are the focus of new monitoring measures. Such concerns that call for adherence to and observation of cultural and intellectual property rights have been addressed and enshrined in the *Chiang-Mai and Kari-Oca* Declarations (Table 2). The first countries to seriously tackle these issues are China and India. Indeed, programmes dealing with medicinal plant conservation, cultivation, community involvement and sustainable development being initiated elsewhere, could benefit immensely from the Chinese and Indian experiences (World Bank, 1997).

Table 2. Medicinal Plants – international concerns and issues

DECLARATION	YEAR	ISSUING BODY	LOCATION
Chiang Mai	1988	WHO/IUCN/WWF International Consultation on Conservation of Medicinal Plants • reaffirms commitment to collective WHO goal of "Health for All by the Year 2000" • recognises that medicinal plants are essential in primary health care, in self-medication, and in national health services • concerned with loss of (*medicinal*) plant diversity world-wide • focuses attention on the economic value of medicinal plants and their sourcing research into development of new drugs.	Chiang Mai, Thailand
Kari-Oca	1992	Kari-Oca Conference on Indigenous Peoples at UNCED focused on: • The need to inventorize, conserve, and bequeath to future generations the existing traditional knowledge of herbs and medicinal plants • Invest indigenous communities with their intellectual and cultural property rights. • Provide rural and non-industrialised communities with easy access to gene banks housing medicinal plant resources through appropriate training programmes.	Rio de Janeiro, Brazil

Genetic biodiversity of traditional medicinal herbs and plants is continuously under the threat of extinction as a result of growth-exploitation, environment-unfriendly harvesting techniques, loss of growth habitats and unmonitored trade of medicinal plants.

Medicinal herbs, possessing penile potency properties and anti-cancer principles are the focus of smuggling to import markets in Germany, France, Switzerland, Japan, the U.K., and the U.S.A. The best known example, in recent times, is that of *tetu lakda* (*Nothadoytes foetida*). Commonly encountered in southern India and Sri Lanka, the herb is exploited as a source of anti-cancer drugs.

On the other hand, *Adonis vernalis*, extinct in Italy and the Netherlands, is an endangered species in Germany, Slovakia, Sweden and Switzerland. Fortunately, to safeguard against such practices and losses, guidelines and licensing concerning the use of such plants are provided for in the *Convention on International Trade Endangered Species of Wild Flora and Fauna* (CITES).

The industrial uses of medicinal plants are many. These range from traditional medicines, herbal teas, and health foods such as nutriceuticals to galenicals, phytopharmaceuticals and industrially produced pharmaceuticals. Furthermore, medicinal plants constitute a source of valuable foreign exchange for most developing countries, as they are a ready source of drugs such as quinine and reserpine; of galenicals like tinctures and of intermediates (e.g. diosgenin from *Discorea sp*.) in the production of semi-synthetic drugs.

The world market for plant-derived chemicals – pharmaceuticals, fragrances, flavours, and colour ingredients, alone exceeds several billion dollars per year. Classic examples of phytochemicals in biology and medicine include taxol, vincristine, vinblastine, colchicine as well as the Chinese antimalarial - artemisinin, and the Indian ayurdevic drug-*forkolin*. Trade in medicinal plants is growing in volume and in exports. It is estimated that the global trade in medicinal plants is US$800 million per year.

The botanical market, inclusive of herbs and medicinal plants, in the USA, is estimated, at retail, at approximately US$1.6 billion p.a. China with exports of over 120,000 tonnes p.a., and India with some 32,000 tonnes p.a. dominate the international markets. It is estimated that Europe, annually, imports about 400,000 t of medicinal plants with an average market value of US$ 1 billion from Africa and Asia. A growing awareness of this new contributor to the foreign-exchange reserves of several national treasuries is beginning to emerge. To satisfy growing market demands, surveys are being conducted to unearth new plant sources of herbal remedies and medicines.

In several industrialised societies, plant-derived prescription drugs constitute an element in the maintenance of health. Medicinal plants are an integral component of research developments in the pharmaceutical industry. Such research focuses on the isolation and direct use of active medicinal constituents, or on the development of semi-synthetic drugs, or still again on the active screening of natural products to yield synthetic pharmacologically-active compounds. In Germany, for example, over 1500 plant species encountered in some 200 families and 800 genera have been processed into medicinal products. In South Africa, likewise, some 500 species are commercialised trade products. Today, Bulgaria, Germany and Poland are recognised as major exporters of plant-based medicinal products.

The development and commercialisation of medicinal plant-based bioindustries in the developing countries is dependent upon the availability of facilities and information concerning upstream and downstream bioprocessing, extraction, purification, and marketing of the industrial potential of medicinal plants. Absence of such infrastructure compounded by lack of governmental interest and financial support restricts the evolution of traditional herbal extracts into authenticated market products. Furthermore the absence of modernised socio-economic and public healthcare systems reinforces reliance of rural and lower-income urban populations on the use of traditional medicinal herbs and plants as complementary aids to routine pharmaceutical market products.

The prophylactic and therapeutic effects of plant foods and extracts in reducing cardiovascular disease has been reviewed (Walker, 1996). Non-nutrient phytochemicals are increasingly being recognised as potential health promoters in reducing the risks of cardiovascular disease and atherosclerosis. Prominent herbs identified were *Achillea millefolium* (yarrow), *Allium sativum* (garlic), *Convallaria majalis* (lily of the valley), *Cratageus laevigata* (hawthorn), *Cynara scolymus* (globe artichoke), *Gingko biloba* (gingko) and *Viburnum opulus* (cramp bark).

Saint-John's wort known as Johanniskrant in German for centuries has been used to treat people with mild and moderate depression without the side effects of Prozac. Widely sold in Germany and other European countries, and awaiting official approval by the US Food and Drug Administration, Saint-John's wort is being regarded as a serious rival to Prozac (Andrews, 1997).

Medicinal plants can make an important contribution to the WHO goal to ensure, by the year 2000, that all peoples, worldwide, will lead a sustainable socio-economic productive life. The Centre for Science and Technology of the Non-Aligned and other Developing Countries in India organised an international workshop on *Tissue Culture of Economic Plants* in April, 1994, as a means of using modern biotechnological techniques to nurture and conserve medicinal plants.

In late 1997, the World Bank, within the framework of the Global Environmental Facility, provided a US$ 4.5 million grant for the *Sri Lanka Conservation of Medicinal Plants Project* which focuses on the conservation of medicinal plant populations, their habitats, and their sustainable use in Medicinal Plant Conservation Areas (MPCAs). Inventories with emphasis on the management, research and conservation of rare and endangered species of medicinal plants are the main programmes at MPCAs at Ritigala, Naula, Rajawaka, Kanneliya, and Bibile.

Aspects of policy and research concerning the cultivation of non-tropical and tropical medicinal plants and their genetic improvement; their conservation in botanical gardens; their storage in liquid nitrogen; their economic potential in international pharmaceutical trade; and their vulnerability to over-exploitation and extinction have been dealt with authoritatively (Akerele et al, 1991; Chadwick and Marsh, 1994). Moreover, such concerns and issues are addressed through a variety of programme activities and projects conducted, and promoted by several international, regional, and non-governmental organisations (Table 3).

Table 3. Examples of activities in medicinal plants sponsored by non-UN and UN agencies

AGENCY	ACTIVITIES	REMARKS
ASCOPAP	• African Scientific Co-operation on Phytomedicine and Aromatic Plants – Internet home of the African pharmacopoeia.	• Mission to promote, and facilitate the research development and commercialisation of safe, effective, and standardised phytomedicines on prudent use of African medicinal plant resources.
EFMC	• European Federation for Medicinal Chemistry	• Objective to advance research in the different

	sponsors biennial international symposium in medicinal chemistry	aspects of medicinal chemistry by promoting co-operation between member organisations participating in the biennial International Symposium on Medicinal Chemistry.
ESCOP	• European Scientific Co-operation on Phytotherapy established in 1989	• To advance the scientific status of phytomedicines. • To assist with the harmonisation of their regulatory status at a European level. • To support and initiate clinical and experimental research in phyotmedicines. • To promote the acceptance of phytomedicines within the therapy of general medical practitioners.
FAO	• Compiles, in early 1980s, initial list of 22 medicinal plants used as raw materials for drug production	• Work is co-ordinated by the FAO Collaborating Centre, the Research Institute for Medicinal Plants, Budakalasz, Hungary. • Commissions report on use of medicinal plants in veterinary medicine in 18 Asian countries.
FIADREP	• International Federation of Associations of Defence in Phytotherapy Research and Training.	• To unify the defence of the use medicinal plants of a pharmacomedicinal quality. • To promote research, practice and education, worldwide, in phytotherapy.
GIFTS	• The *Global Initiative for Traditional Systems of Health* in co-operation with IDRC, has organised meetings on different issues in the following regions:	• Issues special publications dealing with traditional medicine, the biodiversity of medicinal plants, traditional health care, etc.
	Africa: -Recognition of emerging interest in the traditional medicine in treatment of endemic diseases such as AIDS, malaria and other parasitic diseases -Need for community-based medicinal plant conservation and cultivation programmes -Recognition of women as traditional practitioners of herbal medicine in need of appropriate support and training	• Development of standardised protocols for medicinal plant drug research and safety
	Asia: -Herbal and medicinal plant-based health care systems widely recognised -Need to counteract diminishing stocks of medicinal plants through conservation and cultivation programmes -Recognition of women as users, conservers and providers of traditional health services using herbs and medicinal plants	• Accorded varying degree of official support in several countries
	Latin America: -Traditional healthcare knowledge (using herbs and medicinal plants) -Concern over bioprospecting of untapped plant resources as sources of new biomolecules or genes of biopharmaceutical and agricultural significance	• Regarded as inherent component of indigenous cultural knowledge.

ICMAP	• International Council on *Medicinal and Aromatic Plants* (*MAPS*)	• Promotes *Good Agricultural Practices* for the cultivation and propagation of MAPS; development of phytopharmaceutical standards; and organises international conferences focusing on technology transfer, etc.
IOCD	• International Organisation for Chemical Sciences in Development	• Established in 1981, and based in the USA, IOCD organises training activities in medicinal plants (Panama, 1997); traditional medicine (Nepal, 1997) and plant pharmacology (Peru, 1997)
IUCN	• The International Union for the Conservation of Nature and the World Wildlife Fund instituted the joint IUCN-WWF Plants Conservation Programme, which emphasises medicinal plants, as a major conservation is a priority.	• *First phase 1984 – 1987*: The Plants Conservation Programme launched in 1984 comprised of two activity Groups: a. Strategic activities focusing on principles and methods for plant conservation b. Field projects using planned strategic principles and methods • *Second phase 1988 – 1990*: Focuses on: a. Development of A Guide and Strategy for Centres of Plant Diversity and their Conservation b. A Botanic Gardens Conservation Strategy c. Wild plants of economic value
TRAFFIC	• Joint wildlife monitoring programme of the World Wildlife Fund and International Union for the Conservation of Nature.	• International Network issuing authorities reports on the conservation, use, protection and trade of medicinal plants and wildlife resources (inclusive of endangered and rare species of flora and fauna in Africa, Asia, Europe and the Pacific.

UNESCO	• Policy discussion on Protection of Interest in Utilisation of Biological Resources of Developing Countries, Kuala Lumpur, Malaysia, 1996, resulting from the following concerns: -potential loss of medicinal plant biodiversity resulting from over exploitation -loss of potential trade and commercial revenue -loss of potential economic incentive for development of academic and scientific sustainable infrastructures	• Development of a Policy guideline on bioprospecting and the requirements for permitting collaborative biological research and bioprospecting in the South and Southeast region
	- Latin American and Caribbean Network of Aromatic and Medicinal Plants (*LACINMAP*)	Activity set up in 1994 through UNESCO's Programme in General Information, Caracas, Venezuela*
	• Asian and Pacific Network of Aromatic and Medicinal Plants (*APINMAP*) -Development of physical, chemical and taxonomic database of medicinal plants -Development of information services and products for use by Member States	Decentralised Network of following members – Australia, China, India, Indonesia, Republic of Korea, Malaysia, Nepal, Pakistan, Papua New Guinea, Philippines, Sri Lanka, Thailand and Vietnam
	• Botany 2000 is comprised of activities in Asia and Africa. Activities in Europe are confined to support of herbaria in countries in transition and reconstruction e.g. Georgia. Activities in Africa and Asia subsume activities in predecessor networks such as the:	*Botany 2000-Asia* is implemented by UNESCO's New Delhi Office and focuses on the taxonomy, and biological and cultural diversity of medicinal and ornamental plants, and their protection against environmental pollution
	- Natural Products Research Network for Eastern and Central Africa (*NAPRECA*), and the South and Central Asian Medicinal and Aromatic Plants Network (*SCAMAP*).	*Botany 2000-Africa* is implemented by UNESCO's Nairobi Office and deals with the conservation and use of the medicinal flora of Africa

UNIDO	• Provides technical assistance to product development and quality control concerning market and industrial potential for essential oils, medicinal plants, and interactions between the pharmaceutical industry and traditional medicine industry.	• Project activities in Bolivia, Ethiopia, India, Democratic People's Republic of Korea, Madagascar, Nepal, Oman, Philippines, Sri Lanka, Tanzania, Thailand, Turkey, Vietnam, Zimbabwe. • Training activities in medicinal, consumer protection, and indigenous peoples concerns in the practise, use and sustainability of herbal medicines in co-operation with International Institute for Human Resources Development, USA
WHO	• Traditional Medicine Programme. WHO operates network of 19 Collaborating Centres in ten countries: Belgium, China, Democratic Peoples Republic of Korea, Italy, Japan, Republic of Korea, Romania, Sudan, USA and Vietnam	Assists Member States in: - formulation of national policies on traditional medicine - evaluation of practices, safety, and efficiency of remedies - education of general public and upgrading of traditional and modern health practitioners about proven traditional medicinal practices
WWF	• World Wildlife Fund for Nature *People and Plants Initiative* (PPI) amongst other activities such as park use and woodcarving, focuses on:	PPI is a partnership programme incorporating inputs from WWF, UNESCO (through its Man and the Biosphere (MAB) programmes and the Royal Botanical Gardens, Kew, Surrey, UK
	- Assessments plant resources used by local communities in Uganda Pakistan and Nepal	• Courses in ethnobotany (Kenya, Pakistan, South East Asia, Uganda)
	-Developmental activities in primary health-care in Nepal and Uganda -Evaluation of the current role of ethnobotany in formal and informal education in six Central American states -Regional and international workshops on field methods in ethnobotany (Mexico), conservation of medicinal plants (Dominican Republic), joint forest management (India), the cultural context of ethnobotany (Thailand, China) and quantitative methods in ethnobotany (Kenya) -Studies of the use of plant resources by women for food, fuel and medicine in Kenya, Mozambique and Uganda	• Preparation of educational materials, including manuals on techniques in ethnobotany

* Informe Técnico PR/1994-1995/iv. 3.1.

Concluding remarks

Recent and renewed interest in medicinal plants coupled to developments in information technology has fuelled an explosion in the range and content of electronic information concerning medicinal plants as a re-emergent health aid. Bhat (1997) recently reviewed diverse sources of such information in traditional abstracting services as well as in a variety of online electronic databases. As a result of such developments, access to indigenous peoples and cultures concerning medicinal plants are greatly facilitated. Furthermore, the active participation of such natural custodians and practitioners of valuable knowledge is guaranteed in the generation of research focussing on screening programmes dealing with the isolation of bioactive principles and the development of new drugs.

References

Akerele, O., Heywood, V. and Synge, H. (1991). eds., *Conservation of Medicinal Plants*, Cambridge University Press Ltd., Cambridge, UK, pgs. 362.

Andrews, E.L. (1997). A Humble Herb as Rival to Prozac, *International Herald Tribune*,Paris 11 November.

Anjara, J. (1996) Ethnoveterinary Pharmacology in India: Past, Present and Future. In: *Ethnoveterinary Research and Development*. eds. McCorkle, C.M., Mathias, E. and Schillhorn van veen, T.W., Intermediate Technology Publications, London, UK, pgs. 137 – 147.

Bhat, K.K.S. (1997). Medicinal and plant information databases. In: *Medicinal Plants for Forests Conservation and Health Care*. eds. Bodeker, G. and Vantomne, P., FAO, Non-Wood Forest Products Series No. 11, FAO, Rome, pgs. 158.

Chadwick, D.J. and Marsh, J. (1994). eds. *Ethnobotany and the Search for New Drugs*, CIBA Foundation Symposium 185, John Wiley and Sons, Chichester, UK, pgs. 280.

Gorman, C. (1992). The Power of Potions, *Time*, April 20, pgs. 52 – 53.

Lanfranco, G. (1992). Popular Use of Medicinal Plants in the Maltese Islands, *Insula*, No. 1, pgs. 34 – 35.

Lemma, A. (1991). The Potentials and Challenges of Endod, the Ethiopian Soapberry Plant for Control of Schistosomiasis. In: *Science in Africa: Achievements and Prospects*, American Association for the Advancement of Sciences (AAAS), Washington, D.C., USA.

McGee, H. (1988). *In victu veritas*, *Nature* 392:649 – 650.

UNESCO (1996). *Culture and Health*, Orientation Texts – World Decade for Cultural Development 1988 – 1997, Document CLT/DEC/PRO – 1996, Paris, France, pgs. 129.

UNESCO (1998). FIT/504-RAF-48 Terminal Report: *Promotion of Ethnobotany and the Sustainable Use of Plant Resources in Africa*, pgs. 60, Paris, 1998.

Walker, A.F. (1996). Of Hearts and Herbs, *Biologist* 43:177 - 180.

World Bank (1997). *Medicinal Plants – Rescuing a Global Heritage*. eds. Lambert, J., Srivastava, J. and Vietmeyer, N., Technical Paper No. 355, pgs. 61.