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Expert Group Meeting on Industrial
Utilization of Medicinal Plants

Panajachel, Guatemala
11-17 July 1993

REPORT*

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I. INTRODUCTION

Plant-based traditional medicines play a vital role in the health care in developing countries. In most countries of Latin American and the Caribbean region, phytomedicines are still prepared by conventional methods. The richness of Latin American tropical flora offers wide choices of plants for medicinal and economic uses. Modern processing methods will enhance the efficiency of plant extraction, and thus leading to increase in efficacy. The experience in the Asian region has proved that traditional medicines could be processed by using modern technology. In Latin America, this is the first time that UNIDO has convened an Experts' Group meeting on industrial utilization of medicinal and aromatic plants. The experiences gained in the implementation of the Guatemalan and other UNIDO projects in Africa and Asia were shared with countries of the Latin America and Caribbean region.

The objective of the meeting was to provide experts from countries in the Latin American and Caribbean region with assessed information on the technical and economic aspects of technology for processing medicinal plants with a view to initiating or enhancing their own activities and to have a way for cooperation within the region and with other developing countries active in this field. The meeting served as a forum for exchange of experience among specialists and researchers with different levels of R & D experience in medicinal plant-based pharmaceutical manufacturing. It also provided opportunities for the participants to discuss cooperation possibilities in the plant-based pharmaceutical industry.

II. ORGANIZATION OF THE MEETING

The meeting was attended by 18 national delegates from countries of Latin America and the Caribbean. In addition, resource persons from Thailand, Turkey, Vietnam, and Nepal, where UNIDO projects have been successfully completed, also attended the meeting. China was invited as a special case, because of the widespread use of medicinal plants in that country. Mr. Ceferino Sánchez of the University of Panama acted as UNIDO consultant. The number of local participants from Guatemala was 33. The list of participants is attached as Annex I.

Opening of the Workshop

The workshop was formally inaugurated by Mr. Alfonso Fuentes Soria, Rector of the University of San Carlos of Guatemala. He drew attention of the participants to the importance of industrial utilization of medicinal plants and the contributions made by the UNIDO through support to CONAPLAMED (National Commission for the Utilization of Medicinal Plants). The Rector gave a warm welcome to the participants and thanked UNIDO for helping to organize, for

the first time, such a meeting in the Latin American and Caribbean region. He mentioned that the utilization of plants for medicinal purposes is receiving greater attention in the strategies of health care in Latin America and that the topic of the Experts' Group Meeting has a transcendental importance.

The CONAPLAMED Project Director, Ms. Amarilis Saravia, extended a cordial welcome to all participants. She was pleased that this meeting was held in the Latin American region where there is a great potential for industrial utilization of medicinal plants and where plant use by the population is widespread. She wished the participants a pleasant stay in the beautiful town of Panajachel and was very pleased to share the experiences of Guatemala in the UNIDO project. She concluded by saying that "let us all join hands in improving health care of our people by utilizing our medicinal plant resources".

The Acting Chief of ECDC Section, UNIDO, outlined the activities and mandate of UNIDO as well as the objective which UNIDO wish to achieve through this meeting. He expressed, on behalf of the Director General of UNIDO, his sincere thanks and appreciations to the Rector of the University of San Carlos and the UNDP office in Guatemala for making local arrangements. He said that the participants should use the workshop as a springboard for establishing technical and economic cooperation through joint research, joint production, technology transfer, licensing, supply of experts, training, information exchange and/or equipment supplies.

The UNDP Resident Representative in Guatemala stressed the need to improve managerial skills in all technical cooperation projects. He outlined the need of entrepreneurship, and stressed that in order to be competitive, one has to continually improve technological management skills and efficiency. He pointed out the importance of the people as the basis for a successful business in this time of global economic opening of the markets and competitiveness. He stressed the importance of using newer technologies and mentioned that to be successful it is not only necessary to have resources but to "do it differently" and insisted finally that "something that works is obsolete".

The Special Technical Advisor of UNIDO gave an overview of UNIDO's activities during the last 15 years. He defined clearly the objectives of the meeting and expected outcomes. He emphasized the need to have action oriented resolutions so that UNIDO could explore the possibilities of implementing them in a practical manner. He informed the audience about the three types of participants: Government approved participants, resource persons specially selected to share their experiences from Thailand, Nepal, Viet Nam, Turkey and China, and the Unido Consultant, Mr. Ceferino Sánchez, who during the last two months visited several Latin American countries and prepared a position paper entitled "Industrial Utilization of Medicinal Plants in Latin America". He went on to say that he hoped to see the development of operational projects and called the attention of the participants to the office of Economic Cooperation among Developing Countries (ECDC) in UNIDO,

which could help them. He stressed the need of including aromatic plants and mentioned that in the UNIDO's definition of Medicinal Plants, aromatic plants are implicitly involved. He also pointed out that UNIDO's focus is on industrialization and its assistance on Production and Management. The main effort is oriented towards small and medium scale industries, based on medicinal and aromatic plants. UNIDO is, therefore, interested in applied oriented research.

He discussed in detail the role of UNIDO in promoting and accelerating industrialization of developing countries and increasing the share of developing countries in the total world production. He stressed that the UNIDO was committed to offer technical cooperation in all areas of industrial utilization of medicinal and aromatic plants. He discussed the types of programs which the UNIDO generally supports: developmental assistance, consultative programs, exploratory programs to identify needs and promotional activities. The UNIDO's thrust is on country specific programs. In addition, he went on to say that the UNIDO will also help member countries to support small and medium scale agro-based industries, within the context of Agenda 21 of the Rio Conference to include topics like rural development, sustainable development, role of women, and biodiversity conservation. He finally outlined the areas of technical cooperation of UNIDO in the world and hoped for more involvement of UNIDO in Latin America.

A representative of Mr. Vitelio Girón, Governor of the Department of Sololá (Guatemala) and Ms. Juana Mejía de Rodríguez, in representation of the Pan American Health Organization also participated in the opening ceremony.

Election of the Officers

Ms. Amarilis Saravia, President of CONAPLAMED in Guatemala, was elected President of the Meeting. Mr. Gerardo A. Mora, Director of the Natural Products Research Center of the University of Costa Rica and Mr. Mahabir P. Gupta, Director of the Research Center on Pharmacognostic Study of Panamanian Flora, School of Pharmacy of the University of Panama were elected Vice-President and Rapporteur, respectively.

III. SUMMARY OF THE PAPERS PRESENTED AT THE PLENARY SESSION

Mr. Ceferino Sánchez, UNIDO Consultant, presented his report on the status of the industrialization of medicinal plants in Latin America. He described the world pharmaceutical market and related it to the Latin American situation. The region consumes only 5% of the world pharmaceutical market, which represents a per capita consumption of some US\$ 21 per year, but there is a wide difference

in per capita consumption between and within the countries of the region. It is accepted that a significant part of the population (about 50%) does not have access to modern drugs. It is also well known that many people in the region (about 60 to 70 per cent) utilize medicinal plants for their health needs. This situation, together with the decreasing participation of the national governments in the purchase and distribution of pharmaceuticals, the ever increasing control of the industry by the international laboratories, the increased tendency in the utilization of medicinal plants by the developed countries of Europe and the globalization of the economy create the need and the opportunity for industrialization of medicinal plants as an answer to the health needs of the population and as a source of income to the region through the export of medicinal plants and their products.

Mr. Sánchez pointed out the lack of information about the size of the phytopharmaceutical market in Latin America but it seems to be, at present, very low (perhaps less than 1% of the total regional pharmaceutical market). The consultant indicated that the present plant-based industry in the region is not well developed, its market penetration is poor and, in general, its quality is questionable.

He mentioned the lack of proper industrial technology, quality control and standardization procedures, flexible regulations for registration, knowledge of the market, research in agrotechnology and validation, together with poor acceptability by health personnel, difficulty in supply of plants, lack of investment capital and lack of awareness regarding the possible benefits, as the main causes of the poor development of the plant-based industry in the region.

The speaker emphasized the need of the Latin American governments to have a policy to support research and utilization of phytomedicinals, create a flexible framework for its registration as medicines and stimulate industrialization with an appropriate financial and fiscal policy.

In addition he pointed out that the phytopharmaceutical products should be priced in such a way that most of the population could afford them directly or obtain them through the Government. The consultant recommended that this goal can only be achieved by producing good standardized extracts from which finished pharmaceutical preparations with standard dosifications could be manufactured. He stressed the importance of R & D support in the area and the possibilities of exports.

Finally the consultant listed a group of recommendations addressed to the national governments, the academic sector, the productive sector, and the international organizations.

Guatemala

Mr. Armando Cáceres, National Project Director, introduced the achievements and experience through the execution of the UNIDO project (US/GUA/84/282). The main outcomes reported were:

- Inventory of 770 plants used in popular medicine in Guatemala.
- Biological and chemical screening of 300 plants.
- Isolation and characterization of bioactive principles.
- Scaling up from the laboratory to pilot scale.
- Training of personnel and enterprises in the formulation of phytopharmaceutical products, and
- Training and diffusion activity to strengthen the formation of local human resources.

A priority list of 100 plants compiled could serve as the basis of a National Drug List of herbal drugs. The plants recommended for industrialization in the short term are *Allium*, *Bixa*, *Curcuma* and *Zingiber*. On a medium term, *Byrsonima crassifolia*, *Lippia dulcis*, *Neurolaena lobata*, *Petiveria alliacea*, *Psidium guajava*, *Smilax* sp., and *Tagetes lucida*. The experience of Guatemala is useful to the countries of the region, which wish to start a phytopharmaceutical industry.

Nepal

Mr. Asfaq Sheak, informed the meeting of the results obtained through UNIDO assisted programs in Nepal.

In order to promote a quick utilization of herbal based medicine, he stressed the need to develop the extraction industry by formulation industry and directly observe the quality control of the products.

Thailand

Mrs. Sasithorn Wasuwat read her paper entitled "UNIDO's technical assistance R & D of the Industrial Utilization of Medicinal and Aromatic Plants in Thailand 1983-1992".

Thailand has identified five priority plants: *Cassia alata* Linn, for constipation *Andrographis paniculata* Wall., for sore throat, *Clinacanthus nutans* Burn., for local inflammation, *Curcuma longa* for dyspepsia and *Aloe barbadensis* Mill for burns. A drug preparation from *Curcuma longa* Linn was approved for industrial production by the Government's Pharmaceutical Organization in the Ministry of Public Health.

Mrs. Wasuwat offered the services of her Center as a training base for simple extraction, isolation, purification of pharmacological active substance, some biologic screening, formulation into dosage forms, and development of quality control

analytical standards and stability studies.

Turkey

Mr. Baser presented an overview on the world pharmaceutical market and the market of phytopharmaceuticals and essential oils. European market for phytopharmaceuticals was estimated at \$ 2.4 billion in 1991, which represented a 3% share of the total European pharmaceuticals market. Annual growth rate of this sector is 5%. He also gave statistics on herbal exports world wide.

He mentioned that there are 49 factory made plant-based pharmaceuticals products marketed in Turkey and 67 new applications for registration are being considered. In the Turkish Pharmacopeia 150 plant drugs are expected to be included in the future edition.

In addition he informed that the Medicinal Plants Research Centre (TBAM) is to be recognized by the UNIDO as an Interregional Training Center which offered the training course every year from 6-30 September. He also offered the expertise of the Center, specially in the area of essential oils research and processing.

Vietnam

Mr. Nguyen Gia Chan, Institute of Materia Medica Vietnam summarized the results of UNIDO sponsored projects. The following products were actually manufactured by using the pilot plant: artemisinin, D-strophanthin (Divarin), Rutin, Rauwolfia extract tablets, Aranthin and Bidentin from Achyranthes (antihypercholesterolemic), Gindarin alkaloid tablets (sedative), tetrahydroberberine (sedative), A.P.D. (antiparadentosis) and Bach dia Can tablets (analgesic). The results of UNIDO assistance projects were quite impressive.

China

Mr. Jingyu Liang, China Pharmaceutical University, read his paper on "Industrial Utilization of Medicinal Plants in China".

Mr. Liang informed the participants of the role of Traditional Chinese Medicine (TCM) and Chinese Medicinal Plants in health care. He informed that in China there are at the present time more than 1300 factories which produce plant medicines (including 600 TCM factories). 22 them are nationally important enterprises. Over 5700 TCM preparations were produced in 1988. In 1991, the total output value of nation's TCM industries was over 9 billion RMB yuans.

He also outlined the quality control procedures currently used in China. Finally, he summarized some of the results of research on Chinese medicinal plants: Constituents with anticancer activity: pseudolaric acids A and B from the stem bark of *Pseudolarix kaempferi*, two diterpene esters kansuiphori C and D from the root of *Euphorbia kansui*, a sesquiterpene lactone, versicolactone, from *Aristolochia versicolor*; constituents with anti-inflammatory and immunostimulating activities: a new saponin from *Polygonatum odoratum* roots, safflower yellow (mainly safflomin

A), isolated from *Carthamus tinctorius*; constituents with cardiovascular activity: rhyncophylline from *Uncaria rhyncophylla*; constituents with antimalarial activity: artemisinin from *Artemisia annua* and constituents for birth control: marsdekoiside C from *Marsdenia koi*.

He offered technical assistance to the participants in areas of competence of the University.

Argentina

In Argentina there are over 700 medicinal and toxic plants. Plant-based industries are very few, even though in Argentina there are over 150 pharmaceutical companies. Argentina imports around 500 tons of plant extracts for medicinal uses (estimated in US \$ 8 million) and some 20 tons of vegetable heterosides (US \$ 15 million), while it exports around 460 tons of plant extracts (US \$3000,000) and 11 tons of plant heterosides (US \$1.5 million). This excludes aromatic plants. German chamomile (*Matricaria recutita*) is an important aromatic plant, whose export is estimated at US \$20 million.

Argentinean Pharmacopeia lists 57 plant species, of which 20% are native. Argentina still does not accept patents. There are serious attempts towards, establishing the guidelines for the national legislation on the use of herbal products.

Information on research and development centers in Argentina was also provided.

Bolivia

In general, the development of plant-based industry is poor. PROMENAT is one of the small scale industry that produces plant extracts in simple dosage forms. There has been a study by UNIDO mission on the feasibility of production of essential oils.

Brasil

The pharmaceutical market in Brazil is estimated at US \$3 billion per year and two thirds of the population has no access to modern drugs. The participation of phytopharmaceutical products in the total market is estimated at less than 2 per cent. The import of medicinal plants, plant extracts, essential oils, glycosides, alkaloids and steroidal hormones in 1991 reached a figure of US \$ 46 million.

Insofar as the export of medicinal plants, plant extracts and pure phytochemicals, pilocarpine (10,000 kg @ US \$ 1,300/kg) and rutin (250-300 tons @ US \$ 23.00/ton) are the most important. The other plant extracts that are produced in large scale are extracts of *Cynara scolymus*, *Glycyrrhiza glabra*, *Atropa belladonna*, *Rheum palmitatum*, *Rhamnus purshiana*, *Solanum paniculatum*, *Paullinia cupara* and *Cymbopogon citratus*.

There are six medicinal plants, which have been validated scientifically and can be recommended for use: *Ageratum conyzoides* (anti-inflammatory), *Cecropia glaziovii* (Hypotensive), *Maytenus ilicifolia* (Antiulcer), *Mikania glomerata* (Bronchodilator), *Passiflora edulis* (Sedative) and *Phyllanthus niruri* (Kidney stones). These plants are being studied from the agronomic point of view so that they can be cultivated in large scale. Medicinal Plants Germplasm Center in Brazil maintains many accessions of medicinal plants. Brazil, in addition, is developing cultivation of introduced plants such as *Digitalis lanata*, *Duboisia myoporoides*, *Duboisia leidtschardtii*, *Atemisia annua*, and *Papaver bracteatum*.

There are many excellent Centres of research in Brazil, which carry out different aspects of medicinal plants research. Paulista School of Medicine, University of Sao Paulo, Federal University of Rio de Janeiro, and the University of Campinas among others are worth mentioning. It has recently signed a contract with a foreign drug company (Rhone Poulanc) to develop 5 phytopharmaceutical products with bronchodilator, antiulcer, analgesic, anti-inflammatory and anorexic properties. This represents a joint - venture of over US \$ 1.0 million.

Chile

Chile exported over US \$2.5 million worth of medicinal plants in 1992, of which *Quillaia* amounted to US \$ 715,654. *Melissa officinalis*, *Peumus boldus*, *Matricaria chamomila*, *Lippia citriodora*, *Rosa perruna*, *Foeniculum vulgare*, *Smilax medica*, *Buddleja globosa* and *Polygonum sanguinaria* are also important export items.

Phytopharmaceutical industry is not so well developed. Recently, the Ministry of Health has created a Traditional Medicine Unit to look into all aspects of alternative medicine. Interinstitutional committees have been set up to look into the registration of herbal products.

Colombia

There is no well defined governmental policy on the industrial uses of medicinal and aromatic plants. There are small scale companies that prepare phytomedicinals, the quality of the products is, in general, poor. The following medicinal plants were noted as important: *Brugmansia sanguinea*, *Brugmansia arborea*, *Brugmansia candida*, *Cinchona officinalis*, *Cinchona ledgeriana*, *Cephaelis ipecacuanha*, *Solanum marginatum*, *Aloe vera*, *Myroxylon toluifera*, *Salvia palaefolia*, *Calendula officinalis*, *Ocimum basilicum*, *Anacardium occidentale*, *Urtica urens*, *Spilanthes americana*, *Curatella americana*, *Ilex guayusa*, *Physalis peruviana*, *Ruta graveolense*, *Portulacaceae oleracea*, *Senna spectabilis*, *Bidens pilosa*, *Palicourea ovalis* and *Bauhinia picta*. Among the important aromatic

plants which are cultivated are: *Eucalyptus globulus*, *E. citrodora*, *Mentha arvensis*, *M. spicata*, *Illicium verum*, *Pimpinella anisum*, *Foeniculum vulgare*, *Pelargonium graveolens*, *Cananga odorata*, *Rosmarinus officinalis*, *Elettaria cardamomum*, *Laurus nobilis*, *Citrus reticulata*, *aurantifolia*, *limonis* an *Coridothimus capitatus*. Lemongrass is collected from wild sources.

Colombia expects UNIDO to offer technical assistance in technology transfer, training of its personnel in the manufacture and quality control of phytomedicinals, genetic improvements of crops, and feasibility and marketing studies.

Costa Rica

Costa Rica has a very rich biodiversity per km². The Government has not established sound policies in the use and industrialization of medicinal plants. Steps are being taken towards settling up of a National Committee for Medicinal Plants, similar to the one in Guatemala. Central American Tropical Research and Education Institute (CATIE) has expertise in different aspects of cultivation and propagation. Because of the lower prices of traditional crops like coffee and sugar cane, there is an expressed interest on part of agriculturists to look for alternate crops. Micropopagation studies on *Cephaelis ipecacuanha* and *Smilax* sp. have been carried out.

Natural Products Research Center (CIPRONA) at the University of Costa Rica is a leading institution that carries out research on medicinal plants. The Center needs to strengthen its capacity for bioassays and pharmacological evaluations. Infrastructure for chemical work is very good. A UNIDO technical assistance project is in the pipe line. Costa Rica has expressed its needs in relation to market analyses and prospects for commercialization.

Mention was made of the much discussed contract between the National Institute of Biodiversity and the Merck & Co to search for drugs in its biodiversity.

Turmeric, ginger, and chillies are important in the international market. Costa Rica has evaluated the following aromatic plants: lemongrass, vetiver, thyme, *Ocimum* and *Rosmarinus officinalis* etc. Among insecticidal plants which are worth mentioning are: *Quassia amara*, *Ryania speciosa*, *Annona muricata* and *Pachyrrhisus erosus*; and among the medicinal plants *Hibiscus sabadariffa*, *Tecoma stans*, *Petiveria alliacea*, *Senna reticulata* and *Neurolaena lobata*.

Cuba

There is a National Program on Natural products, which comprises the following aspects:

- National Plan for the Research on Medicinal Plants.
- Stratification of the production and distribution of herbal

- drugs and other formulations from natural products.
- Therapeutic guide lines of herbal drugs
 - Guide-lines for drugs of vegetable origin, crude drugs, fluid extracts and tinctures.
 - Guidelines for pharmaceutical specialities for the usage of herbal drugs
 - Information systems: FITOMED I TO IV, FITOTOX and data bases
 - Training programs on medicinal plants for professional and technical personnel in the health system.
 - Dissemination Programs

In Cuba, there are about 8000 plant species, of which about 45-50 per cent are endemic. The pharmaceutical industry is well advanced and produces high quality products. The use of phytopharmaceutical products amounts to about 5 per cent of the total pharmaceutical market. Many plants are cultivated and the Experimental Station Tomás Roig deserves a special mention for propagation and research on cultivation of medicinal plants.

Dominican Republic

Import of the finished phytopharmaceutical products represents only about 0.5 per cent of the total imports. There are a very few local concerns which prepare simple syrups and pack capsules with dried medicinal plants. In 1992, US \$114,000 worth of medicinal plants were exported. Some of the important medicinal plants reported are: *Aloe vera*, *Lippia micromera*, *Mentha piperita*, *Cymbopogon citratus*, *Ocimum basilicum*, *Agave* sp. and *Bixa orellana*. Research on Dominican medicinal plants is carried out mainly at the Natural Products Chemistry Laboratory of the Autonomous University of Santo Domingo. Enda Caribe, an international organization supported by the French Government has been very active in the documentation of popular uses of medicinal plants (TRAMIL) and has published a Caribbean Pharmacopeia.

Ecuador

Ethnobotanical uses of medicinal plants in Ecuador were provided. The use of plants in native populations is widespread. A list of aromatic and medicinal plants in local names was provided. Research on medicinal plants is carried out at the Central University of Ecuador and the Polytechnical School of Riobamba.

Grenada

An extensive list of medicinal and aromatic plants, none of which are indigenous to Grenada, was provided. Mace and nutmeg are the major plants that are exported. Grenada is the number one exporter of mace. Potential for commercialization of herbal veterinary products was suggested.

Grenada's participation in the Organization of American States sponsored EBUTROP (Economic Botany of Underexploited Tropical Plants) project was mentioned. An ethnobotanical inventory of Grenada has been prepared.

Guatemala

The phytopharmaceutical industry in Guatemala is very new. The first steps towards its strengthening were through a UNIDO sponsored National Program with multidisciplinary activities organized in three components for systematization and development: Ethnobotany-Agronomy, Pharmacology-Phytochemistry and Industrialization-Commercialization. There are eight laboratories dedicated to phytopharmaceutical production and commercialization through drug stores, clinics, naturalist centers and supermarkets. These companies manufacture around 115 products, three of them have a wide variety of tinctures made from individual plants. There is a multisectorial Commission to advise the Ministry of Health on legal aspects. It is expected that on a medium-term industrial products of medicinal plants will be incorporated into the national health care system, while strengthening the national phytopharmaceutical industry.

Guatemala has gained experience in the handling of a multifunctional pilot plant. Agrotechnological studies are underway to cultivate *Nerurolaena lobata*, *Smilax* sp., *Tagetes lucida*, etc. A good infrastructure for the pharmacological and biological evaluation of medicinal plants exists at the University of San Carlos and Farmaya. A medicinal plants garden is maintained in Guatemala.

Honduras

The important medicinal plants which are exported are: Chamomile, Calaguala (*Polypodium leucotomos*), ginger, and aloe. There are a few companies that are interested in producing concentrated plant extracts for cosmetic purposes and for the formulation of phytopharmaceuticals. At the present time, the National Autonomous University of Honduras is making a diagnosis of the state of the art of the phytopharmaceutical industry in Honduras. Three to five per cent of the total consumption of drugs is estimated to be phytopharmaceutical products. There are 7 companies dedicated to the production of phytopharmaceuticals, two of which have annual sales ranging from US \$100,000 to US \$ 400,000 and one is considered a large company; its exports are over US \$ 800,000. Only two companies have advanced technology of extraction, purification and concentration of medicinal plant extracts.

Research on medicinal plants is done at the National University, even though it is not organized in a multidisciplinary fashion. Pan American Agricultural School carries out research on the propagation of chamomile and neem. "Helechos Internacionales" exports an ointment made from calaguala for the treatment of psoriasis.

Jamaica

Status of medicinal plants research in Jamaica, carried out at the Pharmacology Department of the University of the West Indies, was presented. Research on *Catharanthus roseus*, *Bixa orellana*, and *Trophis* was mentioned. Canasol has been isolated from *Trophis* which is an effective antiglaucoma drug. A chemical modification of this compound has resulted in anasol for chest colds, wheezing and bronchial asthma. This compound is registered and is on the market. Another product is canavert, which is effective in controlling Meniere's disease and travel sickness. It is registered and awaiting the "art work" to go on the market.

Mexico

It is estimated that around 15 to 20 million Mexicans use traditional medicine. The exact figures are difficult to obtain, as a large percentage of the population covered by the Social Security system also uses traditional medicine. There are over 13,000 traditional healers, of which 53 per cent are midwives, 24 per cent witch doctors ("curanderos"), 17 per cent bone setters and 6 per cent herbalists.

The Secretary of Health has manifested a clear interest in supporting the development of new biotechnological processes with application in the pharmaceutical industry. The following plants are used most frequently: Digestive Tract (*Telosys ambrosoides*, *Artemisia ludoviciana*, *Matricaria recutita*, *Psidium guajava*, *Marrubium vulgare*, *Foeniculum vulgare*, *Persea americana*); Circulatory Tract (*Casimiroa edulis*, *Sechium edule*, *Talauma mexicana*, *Chirantodendrom pentadactylum*); Nervous System (*Citrus aurantifolia*, *Agastache mexicana*, *Tilia mexicana*, *Chirantodendrom pentadactylon*); respiratory tract (*Gnaphalium* sp., *Sambucus mexicana*, *Bougainvillea glabra*, *Thymus vulgaris*); Female Reproductive System (*Montanoa tomentosa*, *Rosmarinus officinalis*, *Lippia dulcis*, *Ruta chalapensis*, *Tagetes lucida*, *Justicia spicigera*); Skin affections and Trauma (*Heteroteca inuloides*, *Oenothera rosea*, *Cuphea aequipetala*, *Solanum chrysotrichum* an *Aloe barbadensis*).

Senna, valerian, and *Passiflora* sp. have been registered in the Public Health Department. MIXIM, the most important company, which manufactures raw materials for the production of drugs, imports 15 per cent of the medicinal plants and the rest are of national origin. Mexico exports *Uva ursi*, *Valeriana mexicana*, *Mimosa tenuiflora* and *Opuntia* sp., while *Peumus boldo*, *Arnica montana*, *Atropa ballandonna* and artichoke leaves are imported. *Dioscorea* is of course one of the most important source of diosgenin which Mexico has used to set up steroid industries.

Panama

In Panama, health care coverage is rather good. There are five American/Indian groups who use traditional medicinal plants for the treatment of their ailments. Country spends over US \$60

million on drugs. However, phytomedicinals are not considered. There are 13 pharmaceutical manufacturing firms in Panama. Two local companies commercialize medicinal plants. *Hibiscus sabadariffa* and *Zingiber officinales*. Traditionally, ipecac has been exported from Panama, however, recent export statistics are not available. There is one local pharmacy that experiments on dried herbal drugs. Panamanian Flora is very rich (8,000 - 10,000 in total) and approximately 12 per cent of the species are endemic.

Present status of research on Panamanian Flora was discussed. Pharmacognostic Research Center on Panamanian Flora in the School of Pharmacy of the University of Panama carries out multidisciplinary research aimed at isolating and characterizing bioactive principles from plants used in traditional medicine. Ethnobotanical inventories of Cuna and Guaymi Indians are available. Thirty new chemical compounds and 97 known compounds have been isolated from Panamanian Plants for the first time. The Center has organized many international training courses and offered its expertise to other centers. Panama has expressed an interest in receiving preparatory assistance from the UNIDO for designing a Technical Cooperation Project aimed at industrialization of medicinal plants. Assistance is needed in agrotechnology, unit processes and process technology, *in vitro* tissue cultures and formulation and production of phytopharmaceuticals products. Panama through the School of Pharmacy of the University of Panama had expressed its desire to be the site for "Center for Information, Training, and Reference for the Pharmaceutical Industry for Central America". This possibility is still viable.

Paraguay

Plant-based pharmaceutical industry is poor. There are only a few small scale local phytopharmaceutical companies. Ethnobotanical inventories of Paraguayan plants are available. The Schools of Chemistry, Natural and Exact Sciences and the Research Institute in Health Sciences, in the National University of Asuncion carry out research on medicinal plants. Previously, a UNDP/UNESCO assisted project has been successfully executed in Paraguay. The Japanese International Cooperation Agency has also supported research on Paraguayan medicinal plants.

Lippia citriodora, *Mentha piperita* and *Bulnesia sarmientoi* are being cultivated. In addition, there is an interest in *Stevia robaudiana*.

Uruguay

In Uruguay, there is very little use of traditional medicinal plants. Ministry of Health has published guide-lines on the use of medicinal plants. The industrial development of this plant-based drugs does not seem to be a very viable option, as the health coverage with modern drugs is satisfactory. The guidelines gives specific common names of medicinal plants, which can be used as herbal drugs.

Venezuela

Venezuela has 56 manufacturing companies with installed capacities to produce all modern pharmaceutical dosage forms of high quality. There is some use of medicinal plants by the natives. There is no agro-industrial development in this sector. Since 1980 there is a special regulation which controls registration, production, and marketing of natural products. There is only one laboratory which manufactures phytomedicinals. Research on medicinal plants is carried out at the schools of pharmacy in the two state universities in Caracas and Mérida and at the Venezuelan Institute of Scientific Research (IVIC). A Postgraduate program in Medicinal Chemistry leading to a M.S. is available at the Central University of Venezuela.

IV. CONCLUSION AND RECOMMENDATIONS

The following recommendations were adopted by the Experts Group:

To the Government:

1. Set up a National Multidisciplinary Committee to assist the Government to formulate policies concerning all aspects of medicinal plants utilization.
2. Establish a national policy to include the use of phytopharmaceutical products in health care.
3. Approval, by the Ministries of Health, of a priority list of medicinal plants to be used for the manufacture of phytopharmaceutical products.
4. Facilitate and simplify the mechanisms for the registration of phytopharmaceutical products, taking into consideration the WHO guidelines and European models.
5. Establish quality control standards for medicinal plants and phytopharmaceutical products.
6. Create a National Institute for the study and utilization of medicinal plants.
7. Support universities, research centers and institutions including agricultural institutes, for carrying out comprehensive studies on industrial utilization of medicinal plants.
8. Promote systematic cultivation and industrialization of medicinal plants and provide incentives for stimulating national plant-based industries.

9. Set up banks of germplasms, seeds and propagable materials of medicinal plants.
10. Offer preferential financial terms to farmers, cooperatives and business enterprises interested in establishing cultivation and industrialization of medicinal plants.
11. Include monographs on selected medicinal plants and their extracts in the national pharmacopoeia.
12. Implement measures for the conservation of medicinal flora, as set forth in the Agenda 21 of United Nations' Conference on Environment and Development.
13. Take measures to collect detailed statistics, under a separated entity, on the figures of import, export and local production of medicinal plants and their products.
14. Strengthen ECDC/TCDC cooperation.
15. Take measures to protect patent rights of the whole phytogeographic region by signing contractual agreements with industrial groups in major pharmaceutical manufacturing countries to whom the medicinal plants are supplied.

To the Universities and Research Institutions:

1. Emphasize the importance of medicinal plants and phytopharmaceutical products in the training of physicians, pharmacists and other related health professionals.
2. Stimulate the creation of specialized centers and support multidisciplinary research aimed at exploring the medicinal and economic potential of the national flora.
3. Initiate postgraduate programs in the field of medicinal plants to prepare qualified personnel in areas related to the industrial utilization of medicinal plants, with emphasis on agrotechnology, process technology, quality assessment, phytotherapy and handling of multifunctional pilot plants.
4. Prepare computerized national inventories of medicinal plant resources which allow exchange of information at a regional and interregional level.
5. Assist the Governments on establishing quality control standards and on legal aspects of registration of phytopharmaceutical products.
6. Promote exchange of scientific and technological information at regional and interregional level.
7. Establish links with the industry to provide technical assistance on different aspects of industrialization of medicinal plants.

8. Improve awareness of the public on the usage of medicinal plants and their products and disseminate the information on industrialization of medicinal plants.
9. Encourage a business outlook among the academicians to facilitate their participation in productive activities and in the industrial utilization of the local medicinal flora.
10. Conduct research on promising lead compounds obtained from medicinal plants for the development of new drugs.

To the Private Sector:

1. Establish links with universities and research centers for industrial utilization of medicinal plants.
2. Call on the National Chambers of Commerce and Industries to promote industrialization of medicinal plants.
3. Form Associations of entrepreneurs and companies interested in the industrialization of medicinal plants, in order to orient them towards the market. This organization should establish contacts with principal foreign markets, as well as have access to modern technology for the production of phytopharmaceutical and natural products.
4. Promote joint-venture agreements between firms which have technology and the knowledge of the market and those that have an access to the traditional knowledge and medicinal plant resources and/or phytopharmaceutical products.

To the International Organizations:

1. Coordinate the efforts of international organizations like UNIDO, FAO, OAS, UNESCO, IDRC, EEC, UNDP, PAHO/WHO, CEPAL, etc. which support technical cooperation programs in different aspects of medicinal plants. Join forces with already existing regional programs, such as the Iberoamerican Program for Science and Technology for Development (CYTED), Enda-Caribe (TRAMIL), etc.
2. Organize training programs for human resource development through workshops, courses, seminars, etc.
3. Support national or regional research centers on medicinal plants and natural products which have well defined goals and relationship with the industrial sector.

4. Promote the creation of a Regional/International Medicinal Plants Research Center, similar to the International Potato Research Center in Lima or the International Rice Research Center in Philippines.
5. Facilitate access to updated information, preferably through computerized data bases on international markets of medicinal plants and the possibilities of industrial investments in this field.
6. Support the creation of networks of collaborating centers on medicinal plants similar to the WHO collaborating centers.
7. Promote cooperation between the research and development laboratories of industrialized and developing countries and among the ones in the developing countries. This can take the following forms: exchange of germplasms and seeds, exchange of information on crops, process technology, formulation of products and marketing practices, and exchange of personnel between R & D institutions for specialized training of personnel.
8. Set up an International Committee to prepare monographs of indigenous medicinal plants, which could be used for quality control purposes.
9. Program periodical meetings, every two years on Industrialization of Medicinal Plants in Latin America and the Caribbean. The Natural Products Research Center (CIPRONA) of the University of Costa Rica offers to be the host for the next Experts' Group meeting.

V. RESULTS OF BILATERAL DISCUSSIONS ON COOPERATION PROJECTS

The bilateral discussions, aimed at identifying specific co-operation activities were held on Thursday, 15 July 1993. A total of 34 TCDC/ECDC activities were identified. The results of bilateral discussions are summarized in Annex 4.

UNIDO encourages follow-up activities to promote practical realization of the working agreements, in particular by means of the use of national or multilateral funds for TCDC and self financed study tours and other activities. The UNIDO Special Technical Advisor urged participants to make contacts with the local UNIDO representatives in their countries to follow up the agreements concluded.

The success of the workshop indicates that the potential for economic and technical co-operation among developing countries clearly exists. Besides the agreements reached, the contacts made during the workshop were very positive and fruitful, particularly for future mutually advantageous co-operation activities.

The Brazilian representatives from CODETEC and CPQBA of the University of Campinas offered to organize regional and interregional courses on different aspects of agrotechnology, quality control, and process-technology of medicinal plants and phytopharmaceutical products. He also mentioned that his institution has the capabilities of designing special training programs to suit the needs of a given country. They will explore the possibilities through their government and the UNIDO office in Brazil to study the feasibility of organizing such an activity.

VI. CLOSING OF THE WORKSHOP

The Experts Group Meeting on Industrial Utilization of Medicinal Plants was concluded on 15 July 1993. The workshop adopted the draft report and requested UNIDO to finalize, reproduce and circulate the final report to all participants.

The Special Technical Advisor and the Acting Chief of ECDC Section of UNIDO placed on record their high appreciation for the hospitality and excellent arrangements made for celebrating this workshop and extended hearty thanks to the University of San Carlos and to Mrs. Amarilis Saravia and Mr. Ceferino Sanchez, who behind the scenes worked for two months in preparing the position paper and the recommendations. The Special Technical Advisor underlined the success of the workshop and thanked all the participants for their contributions. He expressed his commitment to continue UNIDO'S assistance to this region. He also made a special recognition to the President, Vice-President and Rapporteur of the Meeting for their contributions and hard work.

Mr. Roberto Pinzon, Colombian delegate, thanked on behalf of all the participants, UNIDO, Mrs. Amarilis' Saravia, Armando

Cáceres and all their local staff, for their painstaking efforts to make this meeting successful and enjoyable.

Mrs. Amarilis Saravia, President of CONAPLAMED and President of the Meeting expressed her satisfaction with the results of the workshop and expressed her gratitude to the UNIDO for organizing the workshop and underlined the catalytic role UNIDO would have to play in the future to stimulate industrialization of medicinal plants in Latin America. She also thanked all the national delegates and resource persons for their valuable contributions and wished all of them a safe trip back. She officially closed the meeting.

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INSTITUTO GUATEMALTECO DE SEGURIDAD SOCIAL -IGSS-
Guatemala, Guatemala

ANNEX 2

**THE PROGRAMME OF
THE EXPERTS GROUP MEETING ON THE
INDUSTRIAL UTILIZATION OF MEDICINAL PLANTS
Panajachel, Guatemala 11-16 July, 1993**

MONDAY, 12 JULY

Inauguration and welcoming address by:

- Ms. Amarilis Saravia Gómez, President of CONAPLAMED.
- Mr. Ying Lin, Acting Chief, ECDC Section, UNIDO.
- Mr. Alfonso Fuentes Soria, Rector of the University San Carlos of Guatemala.
- Mr. Bruno Guandalini, Resident Representative. United Nations Development Programme (UNDP).
- Dr. Tuley de Silva, UNIDO Special Technical Adviser.

Election of Bureau (Chairman, Vice-Chairman, Rapporteur)

Paper presentations:

- Regional Overview of the Industrial Utilization of Medicinal Plants in Latin America by Mr. Ceferino Sánchez (Panamá).
- UNIDO Technical Assistance in the field of Industrial Utilization of Medicinal Plants and the objective of the meeting by Mr. Tuley de Silva, (UNIDO Special Technical Adviser).

Paper presentations by:

- Mr. Armando Cáceres, CONPLAMED (Guatemala).
- Mr. Asfaq Sheak (Nepal)
- Mrs. Sasithorn Wasuwat (Thailand)
- Mr. Kemal Husnu C. Baser (Turkey)
- Mr. Nguyen Gia Chan (Viet Nam)

TUESDAY, 13 JULY

Paper presentations by:

- Mr. Keman Husnu C. Baser (Turkey)
- Mr. Nguyen Gia Chan (Viet Nam)

Country paper presentation by:

- the invited participants from Latin America and the Caribbean region.

WEDNESDAY, 14 JULY

Paper presentation by:

- Mr. Liang Jin Yu (China)

Country paper presentation by:

- Invited participants from Latin America and the Caribbean region.

Programming Exercise of Technical Co-operation among Developing Countries

THURSDAY, 15 JULY

- General Discussion.
- Conclusion and recommendations.
- Adoption of Report.

FRIDAY, 16 JULY

- Departure to Guatemala.
- Visit to Pilot Plant, Engineering Faculty, USAC.
- Visit to the installations of the Agronomy Faculty, USAC.
Medical Biological Clinic HUMAB-KU
- Visit to Sierra Laboratory.
- Visit to Farmaya Laboratory.
- Guided visit to the Popol-Vuh Museum

- Closing Ceremony

ANNEX 3
 THE RESULTS OF BILATERAL DISCUSSIONS.
 Expert Group Meeting on Industrialization of Medicinal Plants, Guatemala, 1993

PROJECT NUMBER	COOPERATION PARTNERS		BRIEF DESCRIPTION OF THE PROPOSAL
	PARTY A	PARTY B	
1	Thailand Institute of Scientific and Technological Research Sasithorn Wasuwat	Institute of Materia Medica Nguyen Gia Chan	Information exchange, study tour and training in production technology.
2	Center for Drug Research and Development (CIDEM) - Cuba Irina Ramos	Thailand Institute of Scientific and Technological Research Sasithorn Wasuwat	Pharmacological screening with emphasis on anti-inflammatory, anti-infective (antibacterial and antifungal) activities.
3	Center for Drug Research and Development (CIDEM) - Cuba Irina Ramos	China Pharmaceutical University at Nanjing Jingyu Liang	Formulation of drugs from medicinal plants and quality control. Requirements for registration of products.
4	National University of Asuncion, Paraguay Evelio Cardozo	Argentinian Society of Research in Aromatic Plants Arnaldo Bandoni	Analytical techniques of aromatic plants of Paraguay.
5	Department of Drug Administration from Nepal Asfaq Shaek	Pharmacognostic Research Center, University of Panama Mahabir P. Gupta	Cultivation and industrialization of medicinal & aromatic plants. Expert from Nepal for diagnosis of potential medicinal plants for cultivation. Visit to Nepal and exchange of information.
6	National Autonomous University of Honduras Jorge R. Mendoza	Medicinal Plants Research Center Anadolu University, Eskisehir H. Husnu C. Baser	Training of a chemical engineer and chemist from Honduras in production of phytopharmaceuticals. Short-term course for training of local personnel.
7	National University of Asuncion, Paraguay Evelio Cardozo	Multidisciplinary Research Center (UNICAMP) - Brasil Nikolai Sharapin	Training in industrial development of medicinal plants of Paraguay.

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PROJECT NUMBER	COOPERATION PARTNERS		BRIEF DESCRIPTION OF THE PROPOSAL
	PARTY A	PARTY B	
8	Biomedical Research Center of the Mexican Social Security Institute Maria L. Villarreal/Mariana Meckes	Thailand Institute of Scientific and Technological Research Sasithorn Wasuwat	Research on anti-inflammatory and cardiovascular activity.
9	Technological Development Company (CODETEC) - Brasil Benjamin Gilbert	Guatemalan Social Security Institute (IGSS) - Guatemala Juan José Roca Colindres	Screening of antimicrobial activity and clinical research of plants from Guatemala to be applied in the treatment of diarrhea and cholera.
10	Multidisciplinary Research Center (UNICAMP) - Brasil Nikolai Sharapin	Medicinals Plants Research Center Anadolu University, Eskisehir H. Husnu C. Baser	Exchange of information on technological innovation and research in a multidisciplinary research center.
11	Herbs Production and Processing Company Ltd. Asfaq Sheak	Medicinal Plants Research Center Anadolu University, Eskisehir H. Husnu C. Baser	Participation in regular training programme.
12	Institute of Materia Medica Vietnam Nguyen Gia Chan	Center for Drug Research and Development (CIDEM) - Cuba Irina Ramos	Research on the development of new natural drugs.
13	CIPRONA - University of Costa Rica Gerardo Mora	Medicinal Plants Research Center Anadolu University, Eskisehir H. Husnu C. Baser	Training of Costarican personnel on industrial extraction processes, fractionation and purification of active principles and essential oil extraction, purification and analysis.
14	Pharmacognostic Research Center, University of Panama Mahabir P. Gupta	Medicinal Plants Research Center Anadolu University, Eskisehir H. Husnu C. Baser	Extraction of essential oils and its utilization in order to initiate research, development and industrialization of medicinal plants.

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PROJECT NUMBER	COOPERATION PARTNERS		BRIEF DESCRIPTION OF THE PROPOSAL
	PARTY A	PARTY B	
15	Thailand Institute of Scientific and Technological Research Sasithorn Wasuwat	Biomedical Research Center of the Mexican Social Security Institute María L. Villarreal/Mariana Meckes	Establishment of multidisciplinary team for R&D, industrial utilization of herbal medicine from medicinal and aromatic plants. Training in pharmacology and essential oil distillation.
16	China Pharmaceutical University at Nanjing Jingyu Liang	Surco Guatemala Héctor Aristondo	Cooperation between chinese and Guatemala traditional medicine groups and application of medicinal plants to reduce illness in Guatemala. Chinese doctor to train local personnel.
17	Biomedical Research Center of the Mexican Social Security Institute María L Villarreal/Mariana Meckes	Traditional Medicine Unit Ministry of Health - Chile Eduardo Medina	Advise the Ministry of Health to incorporate the herbal medicine into primary health care.
18	Multidisciplinary Research Center (UNICAMP) - Brasil Nikolai Sharapin	Traditional Medicine Unit Ministry of Health - Chile Eduardo Medina	To create the bases to organize the cultivation of medicinal plants and industrial production in Chile
19	Guatemalan Social Security Institute (IGSS) - Guatemala Juan José Roca Colindres	Mexican Institute of Social Security (IGSS) - Mexico María Luisa Villarreal	To investigate the medicinal plants with therapeutic properties and create a blend for the treatment of bacterial diarrhea and cholera.
20	Catholic University of Ecuador Magdalena Ponce	Mexican Institute of Social Security (IGSS) - Mexico María Luisa Villarreal	To determine the promising species of medicinal plants of Ecuador; create a germoplasm bank; tissue culture; ethnobotany; and phytochemistry.
21	Faculty of Pharmacy, Central University - Venezuela Nelson Ferrigni	Multidisciplinary Research Center (UNICAMP) - Brasil Nikolai Sharapin	Implementation of agrotechnological and agrobiological studies of medicinal plants.

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	PARTY A	PARTY B	
22	Center for Drug Research and Development (CIDEM) - Cuba Irina Ramos	Multidisciplinary Research Center (UNICAMP) - Brasil Nikolai Sharapin	Implementation of agrotechnological and agrobiological studies of medicinal plants.
23	PROMENAT Laboratories - Bolivia Rolando Mondaca	FARMAYA Laboratories - Guatemala Lidia M. Girón	To open the Bolivian market for FARMAYA product and the Guatemalan market for PROMENAT products.
24	Department of Pharmacy, National University of Colombia Roberto Pinzón	Multidisciplinary Research Center (UNICAMP) - Brasil Nikolai Sharapin	To receive training in Brasil, to create the conditions to initiate industrialization programs.
25	Drug Control, General Direction of Health Services Marta Regina Fernández	Faculty of Pharmacy and Biochemistry University of Buenos Aires Arnaldo Bandoni	Legal aspects for the control, analysis and commercialization of phytotherapeutics products.
26	Center for Drug Research and Development (CIDEM) - Cuba Irina Ramos	National Autonomous University of Honduras Jorge R. Mendoza	Training of pharmacists and chemical engineers in production processes and analysis of natural products, and the creation of the course of Phytogalenicals in the University.
27	Faculties of Pharmacy and Agronomy University of San Carlos Beatriz Medinilla/Myrna Herrera	Multidisciplinary Research Center (UNICAMP) - Brasil Nikolai Sharapin	Training and research development on specific problems of medicinal plants.
28	FARMAYA Laboratories - Guatemala Lidia M. Girón	National Autonomous University of Honduras Jorge R. Mendoza	Training Honduran personnel in FARMAYA in the formulation and quality control for phytopharmaceuticals.
29	Mexican Institute of Social Security (IGSS) - Mexico María Luisa Villarreal	Multidisciplinary Research Center (UNICAMP) - Brasil Nikolai Sharapin	Training and technical assistance from Brasil with UNIDO financial support.

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PROJECT NUMBER	COOPERATION PARTNERS		BRIEF DESCRIPTION OF THE PROPOSAL
	PARTY A	PARTY B	
30	CEMAT-FARMAYA Guatemala Lidia M. Girón	Multidisciplinary Research Center (UNICAMP) - Brasil Nikolai Sharapin	Standardization of extracts, preparation of standards and definition of norms and standards.
31	VITA-PLANT Laboratories Venezuela	Multidisciplinary Research Center (UNICAMP) - Brasil Nikolai Sharapin	Production processes development for industrialization of phytopharmaceuticals.
32	Autonomous University of Santo Domingo - Dominican Republic Manual Vásquez Tineo	Multidisciplinary Research Center (UNICAMP) - Brasil Nikolai Sharapin	Training medicinal plants processing from collection to production of final product.
33	Drug Control, General Direction of Health Services Marta Regina Fernández	Multidisciplinary Research Center (UNICAMP) - Brasil Nikolai Sharapin	Legal aspects for the control, analysis and commercialization of phytotherapeutic products.
34	School of Pharmaceutical Sciences University of San Carlos Amarilis Saravia	Multidisciplinary Research Center (UNICAMP) - Brasil Nikolai Sharapin	Participation in the course on phytopharmaceutical technology, quality control and extraction of active principles.