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Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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UTILIZATION OF MEDICINAL AND AROMATIC PLANTS FOR A HERBAL PHARMACEUTICAL INDUSTRY

US/GUA/84/282

GUATEMALA

Technical report: Promotion of a pharmacognostical approach to medicinal and aromatic plants*

Prepared for the Government of Guatemala
by the United Nations Industrial Development Organization

Based on the work of Ingrid Borup,
expert in pharmacognosy

Backstopping officer: R. O. B. Wijesekera
Chemical Industries Branch

* This document has not been edited.

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CONTENT

PREFACE

Considering the abundance of Guatemala's flora with the richness and variety of medicinal and aromatic plants and the historical and cultural use of these plants for therapy the Government of Guatemala requested UNIDO to assist in developing a pharmaceutical industry based on the use of natural products.

The whole project UTILIZATION OF MEDICAL AND AROMATIC PLANTS FOR A HERBAL PHARMACEUTICAL INDUSTRY (US/GUA/84/282) is subdivided in different parts. This sub-project (US/GUA/84/282/11-03) deals with the study of the possibilities to introduce and enhance a pharmacognostical investigation programme for potential plants in Guatemala.

This mission was implemented during 6 months, June through November, 1989.
The mission confirmed that there is a great need and interest to promote an effective and coordinated investigation plan in pharmacognosy. Some approaches have already been made in form of promotors and thesis studies.

This documentation outlines

- the present situation in the field of pharmacognosy
- an introduction in theoretical and practical pharmacognosy (serie of conferences and lab courses hold during the mission)
- recommendations to improve the education and efficacity of studies in pharmacognosy

INTRODUCTION TO THE PRESENT PROJECT

1. Background and justification

Guatemala is very uniquely situated. lying between two oceans, the Pacific and the Caribbean with the Atlantic, and at the end of the mountain chain Sierra Madre. It enjoys a tropical climate on both costs, and cold, temperate, wet, and dry climates within the mountain areas. Average temperatures can range from 0 - 35° C and annual rainfall from 30 - 400cm. These conditions produce an abundant flora and fauna, which ranges from the tropical to the Alpine types. Within this ambience also thrives a very rich variety of medicinal and aromatic plants.

Guatemala's population consists of around 60% people of American Indian origin. Their only sources of therapeutic agents are the medicinal plants which they are finding in their surroundings and using in the traditional way. Many of their local remedies have been in use since the Mayan civilisation. The rural folk have much confidence in these remedies.

It would be very rewarding to build up a pharmaceutical industry with medicinal plants, based on the knowledge of the indigenous people, and integrated with modern methods of processing and standardization.

In this process the popular medicine could be monumentally upgraded. Even more people would believe in the potential of remedies of natural products. From the vast arsenal of plant species and ethnomedical practice over millenia, the world could equally benefit in realising new remedies even for until now not curable ailments, whether by using plant extracts such as, or by modelling the active principle to get better and more effective drugs.

Moreover ecological conditions have permitted the local population to take advantage of the native flora, developing new, economically important genotypes. Based on their knowledge the cultivation of indigenous medicinal species as well as the possible acclimatization of foreign species could have considerable scope.

Yet, to realize these tasks, a close study of the active principles of the plants is an absolute necessity, for which a fundamental knowledge of the pharmacognosy is an important prerequisite.

2. Official arrangements

The idea for the project (US/GUA/84/282) started in 1984. CONAPLAMED as executive agency of the government of Guatemala requested assistence from UNIDO to develop an industry based on the botanical resources of the country. The plan for the project was remodelled in 1988. This actual part of the project (US/GUA/84/282/11-03) was founded by West-Germany. It was originally scheduled for a split mission of 3 months in 1989 and another three in 1989. It finally took place for 6 months starting from June 1989.

3. Objectives of the present project

This project was designed to exhibit and improve the topics of pharmacognosy in Guatemala.

The following documentation includes
- a study of the actual position of, and the needs and possibilities for pharmacognosy
- an approach to broaden the theoretical and practical skills in pharmacognosy,
- aspects to improve analytical investigations of medical and aromatic plants in this country.

4. Counterparts

Armando Caceres, National Project Director
Dra. Amarillis Saravia Gómez,
Director, School of Pharmaceutical Chemistry
Luis Fernando Girón, Head, Department of Applied Analysis
Rolando Lopéz, idem

I. ACTUAL SITUATION OF PHARMACOGNOSY IN GUATEMALA

1. Organization

CONAPLAMED is the officially recognized umbrella organisation of 11 institutions of the Republic of Guatemala. (see Annex 1).

The institutions mostly involved in the project (US/GUA/84/282/11-03) are:
- la Universidad de San Carlos
  namely the Facultad de Ciencias Quimicas y Farmacia,
- LUCAM, Laboratorio Unificado de Control de Alimentos y Medicamentos.

2. Status of the participating institutions

2.1. Universidad de San Carlos

Within the Facultad de Ciencias Quimicas y Farmacia there are the Departamento de Analisis Aplicado, which is responsible for the education in pharmacognosy. The instruction takes place every other semester. A semester lasts about three months. During this time there are weekly twice 1 1/2 hour of theoretical instruction and once 2 1/2 hours of laboratory training.

There are two instructors in pharmacognosy with an education in pharmacy and a graduation status as "Licensiatura" which might be comparable with the American Bacchelor.

There are generally about 40 students in each class.

The department has a variety of glassware available but by far not sufficient for 40 students. They have to make group work in parties of four to six each, or even more.

The instrumentation is very scarce. They even do not have an rotavapor, a rotating evaporator, one of the most important equipment for pharmacognostical work.

There are only a few books about pharmacognosy available.

The laboratory, as the glassware, is shared with other groups of pharmaceutical education, like courses in toxicology and microbiology. Still most of the day the laboratories are unoccupied, so that they are by no means efficiently used.

2.2. LUCAM,
Laboratorio Unificado de Control de Alimentos y Medicamentos.

LUCAM is an official institution, under the administration of the Ministry of Health, responsible for the registration and quality control of chemical products, like medicaments. Among 52 staff members there are 15 professionals graduated from the School of Pharmacy or Chemistry.

The laboratories are well equipped with modern analytical instruments, like UV/VIS and gas chromatographs. There even exist a mass spectrometer but it is out of order for several years. The institution is also provided with a good library, notable, prossessing a complete set of Chemical Abstracts.

Yet a lack of expertise in analysing plant products prevents the implementation of the quality control of herbal medicine products.

3. Status of the Universidad del Valle de Guatemala

This University also has a Department of Applied Chemistry. The laboratories are well equipped with glassware and analytical instruments. It could have the potential for basic research in pharmacognosy. But the laboratory as well as the instruments are not sufficiently used. The instrument room has UV/VIS, infra-red, gas-chromatography, HPLC (=High Pressure Liquid Chromatography) and NMR. Most of the equipment is not in use. due to different reasons. There is only one person in charge of all the instruments. Furthermore there are problems with the supply of analytical gases, which are mostly contaminated, and with the purchase of the necessary consumerables and spare parts. Yet one of the main concern is the unstable electricity which causes many problems to the sophistated and sensible instruments. And last not least the number of students is very small, 2-3 per year!!

4. Other pursuits

Beside the above mentioned institutions there are other activities and groups which are propagating interest to enhance a fundamental pharmacognostical investigation of medical and aromatic plants in Guatemala.

In September 1989, like in the years before, "the Semana Cientifica" (Scientific Week) was held with contributions of presentations about pharmacognostical research.

Another important event was the "Seminario Nacional de Medicina Traditional" which took place this October in Quetzaltenago. It was organized by CONAPLAMED and was thought to integrate the field work of "promoters", persons whose knowlegde is rooted in the traditional use of medicinal plants and that is about what they are teaching the people in the villages, with the mostly academically orientated professionals.

Further, in Guatemala already exists a small business in utilising plant resources for the production of medicaments, like CEMAT: ERPLAM (Empresa Rural de Plantas Medicinales)-FARMAYA This undertaking is extracting plants and distributing the extracts as "Tinctura Medicinales" to needy customers.

No doubt that the initiators of this programme have a special interest to produce and distribute medicaments of uniform quality. But this is only possible when the active substances are known and can analytically be specified, and standarized.

Some work in this field is presently going on. Students of the above named pharmaceutical faculty are already in charge doing some research in investigating the active principle of medicinal plants. For, terminating their studies the students have to prepare a thesis. Many of them are choosing a subject in the combined field of pharmacognosy and pharmacology. They are trying to isolate, or rather to concentrate the active principle of the medicinal plants, and to verify and estimate the popular use by evaluating the pharmacological activity of the respective plant.

II. ACTIVITIES AND OUTPUTS

After discussions with the committee members of CONAPLAMED and the UNIDO-expert is was conceded that there is a common request for broadening and strenghtening the theoretical knowlegde and practical skill in the field of pharmacognosy in this country.
They eventually agreed that holding a serie of lectures about pharmacognosy and teaching lab classes in analytical methods, how to investigate medicinal and aromatic plants, would be a sensible approach to fulfill these needs.
It was also consented that the UNIDO-expert should sustain the students in their thesis work.

1. Serie of Lectures

The serial was placed together to give a theoretical overlook over the domain of pharmacognosy. The intention was to point out, that pharmacognosy is not just a limited, subordinated chapter of one single item. But on the contrary, that it is a multiple discipline with links to many other subjects of natural science. Pharmacognosy is a combination of botany, biochemistry, biogenesis, food and pharmaceutical chemistry, and analytical chemistry as well.

The lecture-serial covered the following items:

1.1. Definition and general aspects of pharmacognosy

1.2. Formation and storage of primary components in the course of the primary metabolism of plants

1.2.1. Amino acids and proteins
1.2.2. Fatty acid and lipids
1.2.3. Sugars and carbohydrates

1.3. Formation and deposit of secondary constituents as end products of the secondary metabolism of plant

1.3.1. Segregation tissues for secondary plant substances
1.3.2. Biogenesis of secondary plant components: biogenetic formation of acetogenines, isoprenoids, phenylpropanes, and biogenetic hybrids without nitrogen (-->flavonoids) in the molecule, or with nitrogen (-->alkaloids).

1.3.2.1. Hypothetic formation of alkaloids: structuring of molecules with a nitrogen-free part (C-1, C-2, C-5, C-10, C-6.C-3, C-6.C-2) and a nitrogen-containing part (amino acid, NH3, purin, pyridin).

1.4. Volatile oils

1.4.1. Definition
1.4.2. Occurrences
1.4.3. Industrial preparations
1.4.4. Physical, chemical, olefactory, and gustatory properties
1.4.5. Main chemical constituents
1.4.6. Applications
1.4.7. Analytical considerations

1.5. Alkaloids

1.5.1. Definition
1.5.2. Structuring and classification
1.5.3. Physical and chemical properties
1.5.4. Ocurrences
1.5.5. Extraction procedures
1.5.6. Analytical methods

The lectures were complimented with acetate copies and slides as illustrative material.

2. Laboratory courses

In general the aromatic and medicinal plants can be classified by those constituents which contribute to their main active principle. As such the aromatic plant are characterized by their contents of volatile oil, so are plants containing alkaloids, at which these substances are mainly responsible for their medical application.

Guatemala has an abundant flora in particular of aromatic herbs and alkaloid containing plants. For this reason there exist a special interest for using and industrializing these kinds of plants.

On this account two important species, one of each group, were choosen for the practical work during the lab classes:
- Elettaria cardamomum, Zingiberaceae
- Datura stramonium, Solanaceae

2.1. Elettaria cardamomum

Cardamomum is known as a volatile oil drug. Its components are deposited in the fruits of the plant. The lab course started with a short introduction into the botanical structure of the fruits and the chemistry of the main constituents.
Concerning the practical work special emphasize was laid to demonstrate the different possibilities for extracting an aromatic drug, using Soxhlet extraction and steam destillation, as well as partition separation with suitable organic solvent.

To show the potentials of chromatography and also to have some samples of comparison , two other products were analysed. Lemons were extracted by a solvent maceration, and a consumer good from the local market, which should hold pine oil, by steam destillation and solvent/water partition separation. Both examples should contain some substances equal to cardamom.

Chromatographic separation of the volatile oil was carried out on pre-prepared thin-layer plates, covered with silica gel. To find the right solvent a number of cardamom samples were separted on different microplate using different kinds of pure solvents and mixtures of them. Dichloromethan with 20 - 40 % of hexane proofed to be the best choice. The plates were developed with a anisaldehyde/H_2SO_4 reagent and heated at about 100° C.

The chromatograms showed quite a few spots in different colours disseminated along the whole chromatogram. Comparing the rf-values of the cardamon samples with the samples of lemon, pine and eucalyptus oil, with a considerable probability, four spots could be related to cineol, terpineol, linalyacetate, and terpinylacetate, the four main components of the cardamon oil.

The next step should be a chromatographical separation and and preparative concentration of the main components of cardamon on an chromatographic column. But the time to run a whole column chromatography was by far too short. Nevertheless, filling a column with silica gel the right way could be demonstrated.

2.2. Datura stramonium

This drug is an abundant alkaloid drug in Guatemala. The practical work was preceded by an introduction to the properties of the Solanaceae family which is known to be rich in alkaloids. Equally the properties of the tropane alkaloids, the important alkaloid-group of the Datura species, were explained

For the actual extraction of the alkaloid base two different ways were choosen. One consists in the previous treatment with acid to separate the impurities, followed by alkalinization and extraction of the base with a suitable organic solvent. The other methods immediately starts with an alkalinization and a subsequent solvent extraction.
In the same way samples of Datura candida, another specie of datura, were extracted.

The extractions were analysed by thin layer-chromatography, using silica gel as the layer, aceton-water-conc.ammonium (90+7+3) as solvent, and Dragendorff-reagent as spraying solution.

Solutions of hyoscyaminsulphate and scopolaminhydrobromide were used as standard solutions.

Each chromatogramm of the Datura samples showed one brown spot, related to scopolamin.

With the rest of the Datura sample solutions an identity test resulting in a violet colour, being specific for tropane alkaloids, were carried out, using fuming nitric acid as a reagent.

3. Thesis consultations

Terminating their studies the students of the School of Pharmaceutical and Biological Chemistry of the San Carlos University have to accomplish a thesis, consisting in a small research work. Many students choose a theme from the field of pharmacognosy/pharmacology. These studies shall contribute to the overall interest to investigate the medicinal plants of Guatemala.

The students work consists in literature research, extracting, concentrating, and, if possible, determinating the active principals of the plant under investigation, and in pharmacological testing to prove that the popular use is scientifically justified due to the substantiated action of its constituents.

The activities of this UNIDO project also included a contribution to the thesis work of the students, helping them to find an adequate extraction method and trying to explain the prevailing medicinal action by the potential nature of the anticipated constituents of the medical plants.

During this mission the following plants were under investigation:

3.1. Physalis pubescens and Physalis philadelphica

local name	Miltomate
family	Solanaceae
indication	antibacterial
suggested active principal	steroid alkaloid

3.2. Sambucus mexicana

local name	Sauco
family	Caprifoliaceae
indication	uricosuric, antigouty, diuretic
suggested active principal	alkaloid

3.3. Linum usitatissimum

local name	Linaza
family	Linaceae
indication	antiinflammatory
suggested active principal	mucilage, unsaturated fatty acids

3.4. Diphysa carthagenensis

local name	Guachipilin
family	Leguminosae
indication	antifungal
suggested active principal	flavonoids (pterocarpanes)

3.5. Gliricidia sepium

local name	Madre cacao
family	Leguminosae
indication	antifungal
suggested active principal	flavonoids (pterocarpanes)

3.6. Piscidia piscipula

local name	Barbasco
family	Leguminosae
indication	antifungal
suggested active principal	flavonoids (pterocarpanes)

3.7. Tamarindus indica

local name	Tamarindo, (Guacchil)
family	Caesalpinaceae
indication	diuretic
suggested active principal	invert sugar, fruit acids

3.8. Crotolaria guatemalensis

local name	Chipilín
family	Fabaceae
indication	sedativa, hypnotic
suggested active principal	?

3.9. Rhizophora mangle

local name	Mangle
family	Rhiziphoraceae
indication	against Candida albicans
suggested active principal	tannines

3.10. Byrsonima crassifolia

local name	Nance
family	Malpighiaceae
indication	against shigella
suggested active principal	Vit.C, bioflavonoids

3.11. Moringa oleifera

local name	Paraiso Blanco
family	Moringaceae
indication	antiflammatory/antispasmodic
suggested active principal	mustard oils

3.12. Cymbopogon nardus

local name	Té de limón, Citronella
family	Poaceae, Graminea
indication	repellent
active principal (isolation of citral)	essential oils

3.13. Spilanthes americana

local name	-
family	Asteraceae,Compositae
indication	local anaesteticum

active principal has probably insecticidal activity

4. Field trips

In the term of this project one field trip to Cobán took place. Cobán is situated in a mountainous area north of the City of Guatemala. Its semi-tropical climate makes Cobán an unique place for an abundant flora. Near this little town the University of San Carlos holds a farm with departments of a few faculties. The agricultural sections operates some research plantations of coffee, bananas, strawberries, cardamon, and others. Its also maintains a terrain with a small selection of medicinal plants.

During the expert's visit of the station she learned about forty plant species growing in the area of Cobán, and are being used by the indigenous people for all kinds of ailments. listed as follows:

	Local name	cure and/or use for
1.	Manzana Rosa	diabetes
2.	Escobillo	inflammation of kidneys
3.	Lantén	gastritis
4.	Cardo Santo	nerves
5.	Locab	whooping-cough
6.	Cáscara de Encino	toothache
7.	Hierba del Cáncer	pustules
8.	Cana de Cristo	infections of the urinary tract
9.	Sacquiol	arthritis
10.	Guarumbo	infections of the urinary tract
11.	Níspero	infections of the urinary tract
12.	Pino	whooping-cough
13.	Pepita de Aguacate	mumps
14.	Anona	colics
15.	Santo Domingo	inflammation of the stomach
16.	Caqui Ach	injuries
17.	Mozote	a quick delivery
18.	Chacamil	allergies
19.	Obel	stomachache
20.	Ik Pim	toothache
21.	Ichbut	nursing mothers
22.	Lohasam	allergies and pustules
23.	Titarac	distortion of ankles and arms
24.	Cumpap	seed-staining against insect dammage
25.	Chomajij	abscesses
26.	Marbama	cancer
27.	Cuyac	glue of good quality
28.	Cuc Queen	purgative for taenia
29.	Chinchin de Duende	chronic allergies
30.	Pachte de Monte	shock effects
31.	Hiel de Vaca	injuries
32.	Calambre de Monte	stomachache
33.	Chu Ken (Ccayccam)	internal inflamations, diuretic
34.	Am Che	heals wounds
35.	Verbena de Monte	grippe, influenza
36.	Chamach	disenteria
37.	Cola de Caballo	kidneys
38.	Liqudambar	irritation of the throat
39.	Ach (Ax)	injuries

III. CONCLUSIONS

1. Lectures

The lectures found a good resonance. The audience was composed of two groups, professors from the University of San Carlos, and professionals from other institutions, from the College of Pharmacy and Chemistry, and private enterprises. The listeners were pleased by the variety of the items being presented in the lectures. Many of the items discussed were not known before, notable the surprising fact that pharmacognosy is a big conglomerate of many different disciplines.

The lectures well exposed that in pharmacognosy there does not just exist a one way of extracting active principles of plants.
On the contrary there are a whole lot of different methods depending of the botany and the part of the plant, where the active principal is supposed to be accumulated. Another hints how to procede with the extraction may also be given by the taxonomy and the biochemistry of substances of parent species of the same plant-family. And finally the last confirmation about the nature of an active principal can only be made by isolating it as a pure substance, and by running and evaluating all the possible spectra like UV, IR, mass, NMR.

The lectures were as well attended in the end as in the beginning proving that there prevails a real need for pharmacognostical schooling in Guatemala.

2. Laboratory courses

The courses in practical pharmacognosy could proved to be of the same interest as the lectures. Special involvement could be noted for the different extraction methods and the application of thin-layer chromatography. We also started column chromatography but due to the time lack (two hours lessons, yet the run of a column chromatography needs up to one whole day or even more) this procedure could not be completed.

Yet the courses revealed a big problem. The pharmacognostical sections does not have enough glassware and other equipment available so that every student could make his own experiments. Many equipment is in bad shape or not in stock at all. On this account a rotavapor, one of the basic requirement of a pharmacognostical lab, as well as a UV-detection lamp for thin layer chromatography had to be borrowed from other sections of the faculty.

The courses also disclosed other substancial problems.
The pharmacognostical laboratory is shared with other disciplinary groups of the faculty, yet not in terms of days or weeks but in periods of a few hours, for pharmacognosy i.e. are two to two and a half hours available. By that, a persistency in the education is not possible. All preparations which have been made for one class have to be cleared away thereafter and rearrange before the next one. This method results in a very ineffective teaching. Moreover, for many essays there is not enough time at all.
The present situation, classes of 2 to 3 hours, once every week, and one over the other semester is not efficient at all.

3. Thesis consultations

The thesis work is basically a senseful idea. But the consulting of the students led to other impressions, too. For many of the students this task is asking to much of them concerning time and possibilities to do the work. They get frustrated and loose their interest because the prerequisite to do scientifical investigations are very modest. There are neither enough books nor sufficient equipment available. And last not least, certainly not everybody is dedicated to do research work.
But there are surely some exceptions with a few students "scraping" together what they can get, and finding a way to at least concentrate the active principal of the plant under investigation. Yet a final evidence of the nature of the active substance they also will not be able to deliver with the means and within the time they have available.

4. Field trip to Cobán

The director, Ing. Agr. Etrain Bran M., of the agricultural station of the San Carlos University in Cobán was very pleased with the visit of the UNIDO expert. He and his staff showed her everywhere around, explaining the different activities they are doing and the plants they are working with. Their overall concern consist in cultivating and studying the best growing conditions of Guatemalan plants which have or could have a special importance for medical or industrial use (Cardamomum, Zingiber, Papaya, and Anatti).

They also showed interest to enlarge the collection of medicinal plants in their medical garden. The proposed terrain is big enough to commensurate with such plans. A garden of this kind could contribute to rescue dangered plant-species and also to conserve the knowledge about the curative plants.

RECOMMENDATIONS

ad III. 1. Lectures

The lectures should be continuated. Pharmacognosy is an immense field and cannot be treated thoroughly within one academic semester. An outside expert will be needed to continue this effort.
The conception of materia medica studies should be introduced in other courses, too, such as: Systematic Botany, Industrial Pharmacy, Pharmacotechnic, Chemical Pharmacy, and Social Practice.

ad III. 2. Laboratory courses

1. The pharmacognostical section must be well equipped with glassware, other general lab equipment, reagents (specially standard-substances), and spectral optical instruments.
   A list about proposed equipment will be found in Annex 2.

2. The practical courses in pharmacognosy should be reorganized.

   The lab classes should be hold in whole blocks: every day of the week and all the day long, for 4 to 6 weeks. They should contain one part of exercises in analysing and identifying medicinal plants, and another part of isolating pure substances out of them, being diagnosed by UV- and IR-spektra. Only by this way the students could be fundamentally trained in pharmacognosy so that they can applicate their experience for further studies of indigenous medicinal plants of Guatemala in a profitable way for the country.

ad III. 3. Thesis

The thesis should be newly co-ordinated within the framework of the pharmaceutical education.

Phytotherapy is a substantial part of Guatemalan medication. On this account the students of pharmacy should begin their studies with practical work in the field. Living in the countryside for 3 to 6 months, studying the indigenous plants, and their popular application on the site, and putting together a herbarium would give the students a basically understanding about the essence of pharmacy.

This study would also add to a survey of the curative plants of that area.

After these introductory studies students will pass a four to four and a half year of studies at the university. Thereafter they should have two possibilities to perform their thesis.

Those students which are dedicated to academical research work should start an investigation of the active principle of a certain plant, perhaps one of which they met during their field studies, and in which they were specially interested in. Yet the other students, who like more the praxis should go back to the countryside for another 6 months and work in the medical dispensaries of the indigenous people, and writing about their experience of that place.

The idea behind the experiment of staggered pharmaceutical education is to come to more understanding between the both parties, the one with a more academically influenced medicine and the other with a more popular one. These integrated studies with personal contacts to both sides could substancially improve the mutual confidence, help to conserve the knowlegde about medical plants, and be fruitful for the medical care of the whole nation of Guatemala.
It could also propagate the industrialization of medical plants.

ad III.4. Agricultural station at Cobán

The expansion of the medical garden at Cobán could be a great opportunity for this station to get involved into an even greater concept of substantial contribution to pharmacognostical investigations of medical plants.
The implementation of excursions to see the medical garden and to study the botany of medical plants in the surroundings of around Cobán could be beneficial for the students to learn more about curative plants.

This could be a promising start for an even more fruitful integration of the work on the agricultural station in Cobán with the research projects of the pharmaceutical faculty in the City of Guatemala.

It could also be an advantageous idea to install a small pharmacognostical laboratory within the university complex of Cobán. In the frame of their thesis students could do extractions of plants near the environment where the plants are growing. So the plants are handy to collect, they are fresh, and the problem that the active principal might be decomposed before investigation is reduced. Also fresh plants could be included into the research work.

The integration of a laboratory on the external station of the university would certainly also be boosting the interest in medicinal plants of the station itself. An intensified backfeeding about other plants of interest in the area would be thinkable.

In view of these possibilities my recommendations would be to support the amplification of the medical garden. Further to install a small-scale laboratory with equipment to be able to extract plants, and to perform screening tests by thin-layer chromatogtraphy.

The ethnobotanical and agricultural work of the National Commission for 1990 will focus on Cobán. It is expected that the Agricultural Station will be involved in this effort.

5. Advanced studies and training

To improve the standard of the academical knowledge in Guatemala one or two students who have finished their "Licenciatura" at the USAC should be given the opportunity to persue their pharmacognostical studies in Mexico, the USA or in Europe, heading for the master's and PhD degree. During their graduation studies they should concentrate on the extracting, isolating, and elucidating active principals of guatemalan plants and broadening their knowledge in theoretical pharmacognosy as well, to acquire the tools to raise a well founded research about medicinal plants and aromatic herbs in Guatemala thereafter, to be able to influence the whole country in the sense of utilizing the natural plant resources to improve medical care and to open possibilities for otherwise profitable ways.

Annex 1

National Commission for Utilization of

Medicinal Plants

CONAPLAMED

- Universidad de San Carlos, USAC:
  Facultad de Ciencias Quimicas y Farmacia,
  Facultad de Agronomía y Facultad de Ciencias Médicas
- Centro de Estudios Folklóricos, CEFOL
- Centro de Estudios Conservacionistas, CECON
- Ministerio de Salud Pública y Asistencia Social
- Laboratorio Unificado de Control de Alimentos y Medicamentos, LUCAM
- Unidad Sectorial de Planificación Agropecuaria y de Alimentación, USPADA
- Instituto de Investigación y Tecnología Agrícolas, ICTA
- Centro Mesoamericano de Estudios sobre Tecnología Apropriada, CEMAT
- Secretaría General del Consejo Nacional de Planificación Económica, SEGEPLAN
- Instituto Indigenista Nacional, IIN

Annex 2

Proposed laboratory equipment:

Ultra-mixer
drug mill
water baths, kind bain marie in serie (6 places)
soxhlets
reflux-refrigerators
water-cooling system
vaccum-pump
rotavapors
reduction joints
pipettes, different sizes
pasteur pipettes
sucking rubbers
graduated cylinders
measuring flasks
melting-point capillaries
stands,rods, and clamps rings
destillation flasks, micro and makrostyle (10ml up to 1000ml)
cork-rings
erlenmeyer (50, 100, 250, 500ml)
beakers (10, 25, 50, 100, 250, 500ml)
separation funnels
funnels
filter paper
applicator instrument for preparative thinlayer chromatography
development chambers
sprayers for developing solutions
heating oven
heating plates
UV-lamp
magnetic stirrer
magnetic rods
whirly mixer
lab-boys
pH-paper
test-plates
evaporation bowls
spatules
chromatography columns of different sizes
vaccum and water tubes
tube clamps
ex-prof refrigerator
freezing box
cooling room to store solvents
Escape-ventilation system
woolf-bottles
buechner funnels
micro-balance
balance up to 2kg
nitrogen tanks
manometer
centrifuge
uv/vis spectrophotometer
ir-spectrometer
thin- and thick-layer plates

Amendment to the Recommendation
concerning: Report from November 15, 1989,
Project Nr. US/GUA/84/282/11-03
Guatemala

In the discussions during the debriefing on January 18 and 19, 1990 with the UNIDO in Vienna further aspects arised how to continue the project about the industrial utilization of medicinal plants and aromatic herbs in Guatemala.

As a following-up of the report I will summarize the main points to carry on the project.

During the stay of the expert in Guatemala a pilot plant to extract essential oil from aromatic plants have been ordered and will arrive very soon. But to start a pilot plant and to commercialize the products a quality control is an absolute necessity. The primary material has to be analyzed to guarantee the authentic starting material and to prove that the herbs contain the important constituents in the desired quality and quantity. Because plants, even of the same specie come in different varieties and with different compositions and amounts of characteristic substances.

Alike important is the quality control of the finished products to monitor the production conditions and to guarantee a final product of equal quality.

To assure a quality assessment of the primary material and the finished product the installation of a quality control laboratory directly joined to the pilot plant is necessary.

The narrow connection with the pilot plant would also have the advantage, that it can be better organized and supervised and that there is a better control over the equipment because the lab would not be used of students' groups for other subjects like toxicology and microbacteriology.

To establish a quality control laboratory there are the following actions to be done in the near future.

As prerequisite the Guatemalan side has to guarantee the provision

+ of the building, as well as
+ the electrical, water and sanitary supply.
+ Also the lab furnishing must be provided.
+ 2 to 3 full-time peopie to interact with the expert

Note: Before the laboratory is going to work a stabilized electricity must be guarantees. How are the opportunities to install a stabilizer and, or generator must be discussed.

The UNIDO will deliver the basic equipment to start functioning a quality control laboratory:

+ laboratory
+ glassware
+ chemicals for 2 years
+ gas chromatograph and integrator with standard consumables (columns, syringes, chart paper, etc.) for the first two years,
+ ir-spectrometer,
+ uv/vis spectralphotometer,
+ standard selection of books for chemistry and pharmacognosy;
+ a car, which is exclusively to the disposition of the international expert during his mission in Guatemala.

The Guatemalan side takes over the operating and maintenance costs as well as the fixed costs (taxes and insurance), and necessary reparations.

The UNIDO will also send

+ more international expertise in pharmacognosy for at least 12 months.
+ and finance the graduate studies of a Guatemalan student at an university abroad (USA or Spain).

After terminating his master's or doctor's degree this student should be installed as director of the quality control laboratory. He may give lectures and run courses in pharmacognosy at the University of San Carlos, to transfer his knowledge, obtained abroad, to other Guatemalan students. In his way the overall experience of pharmacognosy could be built up in Guatemala. By then the quality control laboratory could also be serving regularly as study and research laboratory for two to three students, to prepare their thesis work.

File: Lab. Glassware Page 1
Report: Lab. Glassware

ITEM	SIZE	QUANTITY	Cat. Nr.
Beaker	25 ml	25	9.013 014
Beaker	50 ml	25	9.013 017
Beaker	100 ml	20	9.013 024
Beaker (high)	250 ml	20	9.013 036
Beaker (short)	250 ml	20	9.013 136
Beaker (short)	400 ml	20	9.013 041
Beaker (short)	600 ml	20	9.013 048
Beaker (short)	1000 ml	5	9.013 054
Buechner Funnel, porcelain	4,5 cm	6	9.252 045
Buechner Funnel, porcelain	12,5 cm	6	9.252 125
Centrifuge Tubes	0-15 ml	30	9.315 416
Centrifuge Tubes	24x100	20	9.315 014
Centrifuge Tubes	34x100	15	9.315 017
Chromatography Chamber for TLC	10x10	2	Camag 2515
Chromatography Chamber for TLC	20x20	2	Camag 2525
Chromatography Column	2cm/25cm	10	-
Chromatography Column	3cm/50cm	10	-
Chromatography Column	5cm/40cm	5	-
Chromatography Column	5cm/100cm	5	-
Condenser	300 mm	6	9.012 543
Condenser	400 mm	4	9.012 505
Connection with cock	29/32	2	9.012 317
Connection without	29/32	2	9.012 313
Desiccator	200 mm	2	9.042 238
Desiccator	250 mm	2	9.042 243
Destillation Aufsatz	29/32, 29/32	2	9.012 183
Erlenmeyer Flask (simple)	50 ml	20	9.141 017
Erlenmeyer Flask (simple)	100 ml	20	9.141 024
Erlenmeyer Flask (simple)	250 ml	20	9.141 036
Erlenmeyer Flask (simple)	500 ml	10	9.141 044
Erlenmeyer Flask (simple)	1000 ml	10	9.141 054
Erlenmeyer Flask (simple)	2000 ml	2	9.141 063
Erlenmeyer Flask (with stopper)	100 ml	30	9.012 013
Erlenmeyer Flask (with stopper)	250 ml	20	9.012 014
Erlenmeyer Flask (with stopper)	500 ml	10	9.012 015
Evaporation bowl	10 ml	10	9.000 110
Evaporation bowl	60 ml	10	9.000 113
Filtration Funnel	27/110 mm	10	9.052 216
Filtration Funnel	50 ml	6	9.052 304
Fitration Appliance	160x16mm	2	9.051 519
Flat Bottom Flask	50 ml	10	9.011 882
Flat Bottom Flask	100 ml	10	9.011 883
Flat Bottom Flask	250 ml	10	9.011 884
Funnel	35 mm	10	9.251 123
Funnel	55 mm	10	9.251 133
Funnel	70 mm	20	9.251 138
Graduated Cylinder	10 ml	10	9.274 071
Graduated Cylinder	25 ml	20	9.274 072
Graduated Cylinder	50 ml	10	9.274 073
Graduated Cylinder	100 ml	10	9.274 074

File: Lab. Glassware
Report: Lab. Glassware

ITEM	SIZE	QUANTITY	Cat. Nr.
Graduated Cylinder	250 ml	10	9.274 075
Graduated Cylinder	500 ml	10	9.274 076
Graduated Cylinder	1000 ml	4	9.274 077
Intermediate receivers	14/23	2	9.012 611
Intermediate receivers	29/32	2	9.012 623
Jar with screwing cap	50 ml	50	9.072 000
Jar with screwing cap	100 ml	20	9.072 001
Jar with screwing cap	250 ml	20	9.072 002
Jar with screwing cap	500 ml	20	9.072 005
Joint-Connection	-	5	9.011 750
Melting Point Tubes	1 mm	100	9.208 100
Microfiltration Funnel	2 ml	10	9.052 854
Mixer Jar for blender	1000 ml	2	9.571 450
Pasteur Pipettes	-	200	9.411 015
Pipette full	5 ml	10	9.273 607
Pipette full	10 ml	10	9.273 612
Pipette full	20 ml	10	9.273 614
Pipette full	25 ml	10	9.273 615
Pipette full FORTUNA	50 ml	6	9.273 450
Pipette graduated	0.5 ml	10	9.272 105
Pipette graduated	1 ml	20	9.272 106
Pipette graduated	2 ml	20	9.272 109
Pipette graduated	5 ml	15	9.272 111
Pipette graduated	10 ml	10	9.272 113
Pipette graduated	25 ml	6	9.272 115
Pipette graduated	50 ml	6	9.272 116
Pointed Flask	10 ml	10	9.012 021
Pointed Flask	25 ml	10	9.012 022
Pointed Flask	50 ml	10	9.012 023
Pointed Flask	100 ml	10	9.012 024
Powder Funnel	80 mm	2	9.251 725
Rotavapor flask pear	100 ml	2	9.196 081
Rotavapor flask pear	250 ml	2	9.196 082
Rotavapor flask pear	1000 ml	2	9.196 084
Rotavapor receiver flask	1000 ml	2	9.196 254
Round Bottom Flask	50 ml	20	9.011 835
Round Bottom Flask	100 ml	20	9.011 840
Round Bottom Flask	250 ml	20	9.011 845
Round Bottom Flask	500 ml	20	9.011 850
Round Bottom Flask	1000 ml	10	9.011 855
Separation Funnel	50 ml	20	9.203 322
Separation Funnel	100 ml	20	9.203 323
Separation Funnel	250 ml	20	9.203 325
Separation Funnel	500 ml	15	9.203 328
Separation Funnel	1000 ml	10	9.203 330
Soxhlet	100 ml	6	9.043 003
Soxhlet	250 ml	6	9.043 005
Soxhlet	500 ml	2	9.043 006
Soxhlet	1000 ml	2	9.043 007
Suction Flask	500 ml	5	9.051 444

File: Lab. Glassware
Report: Lab. Glassware

ITEM	SIZE	QUANTITY	Cat. Nr.
Suction Flask	1000 ml	5	9.051 454
Suction Tube	160mm/12mm	5	9.051 327
Test Plate for Alcaloids	porcelain, 6	1	-
Test Tubes	10x100 mm	500	9.190 006
Test Tubes	16x160 mm	1000	9.190 021
Test Tubes	20x180 mm	100	9.190 028
Test Tubes graduated with stopper	10 ml	50	9.190 508
Test Tubes graduated with stopper	25 ml	30	9.190 521
Volumetric Flask	5 ml	10	9.276 003
Volumetric Flask	10 ml	100	9.276 643
Volumetric Flask	25 ml	100	9.276 752
Volumetric Flask	50 ml	50	9.276 755
Volumetric Flask	100 ml	30	9.276 757
Volumetric Flask	250 ml	10	9.276 451
Volumetric Flask	500 ml	6	9.276 452
Volumetric Flask	1000 ml	4	9.276 453
Washer(suction tube)	12mm/6mm	10	9.209 146
Weighing Boats	-	10	9.301 066
Weighing Boats	65 mm	10	9.301 066
Wulff`sche Bottle	1000 ml	4	9.305 324
Zweihalsaufsatz + Ansatz	29/32, 29/32	2	9.012 113

File: Lab. Electro Page 1
Report: Lab.Electro

ITEM	MODEL	MANUFACTURE	QU	Cat. Nr.
Analysis Mill	-	Retsch	1	9.738 960
Analytical Balance	-	Mettler	1	KK 152-110
Balance	-	Mettler	1	KK 158-430
Centrifuge	EBA 5 S	Hettich	1	9.943 207
Compressor	-	Boge	1	-
Drying Oven	-	Hereaus	1	9.867 043
Evaporator	Rotavapor R121	Buechi	2	9.812 452
Fraction Sampler	for chromat.columns	-	1	-
Gas Chromatograph	HP 5890A	Hewlett-Packard	2	-
Graphic Printer	for Photometer	Shimadzu	1	-
Heating Mantle	500 ml	-	2	9.641 925
Heating Mantle	1000 ml	-	1	9.641 926
Heating Mantle	2000 ml	-	1	9.641 927
Heating Plate	IKAtherm HCT	IKA	2	9.645 013
Heating Plate-Mag.Stirrer	IKAMAG RH	IKA	2	9.720 216
Hydrogen-Generator	-	Dosapro	1	-
Integrator	HP 3392A	Hewlett-Packard	1	-
IR Spektrometer	-	-	1	-
Laboratory Hood	-	-	1	-
Magnetic Stirrer	IKAMAG MINI-MR	IKA	2	9.720 212
Magnetic Stirrer	IKAMAG-KMO 1	IKA	2	9.720 213
Microdoser	-	Desaga	1	9.539 315
Photo Copier	-	-	1	-
Refrigerator ex-proof	280 l	-	1	-
Refrigerator ex-proof	140 l	-	1	-
Spektrophotometer	-	-	-	-
TAS-Oven	-	Desaga	1	9.539 380
Testtube Whirler	IKA-Vibro-Fix VF 2	Janke & Kunkel	1	9.730 002
UV-Lamp	-	Camag	1	Camag 29064
UV/VIS Spectralphotometer	-	-	1	-
Vacuum Membrane Pump	MZ 2 C	-	2	9.880 825
Vacuum Pump	TomJet	Genser Scientif	1	-
Waring-Blender	-	Breda	1	9.571 436
Water Bath	for Rotavapor	Büchi	2	9.812 401
Water Bath	6 places in serie	GFL	2	9.905 942
Water Cooling System	circulating	Haake	1	KK 232 027
Water Distillery	2008	GFL	1	9.910 608

File: Lab. miscel. Page 1
Report: Lab. miscel.

ITEM	SIZE	QUANTITY	Cat. Nr.
Antona-Apparat	-	1	9.030 201
Boiling Perles	3 mm	100 g	9.012 403
Boiling Stones	-	1 pack.	9.012 306
Bosshead	-	20	9.224 289
Bosshead	-	15	9.225 201
Bosshead (double)	16 mm	20	9.224 250
Bosshead (double)	cross	10	9.224 260
Brushes	15 mm	10	9.019 030
Brushes	for pipes	1 Pack.	9.019 005
Burette Holder	simple	6	9.225 151
Burette Holder	double	3	9.225 162
Check Valve	-	1	9.303 040
Clamp	three finger	5	9.224 657
Condenser Clamp	-	10	9.224 765
Cork Driller	5-11	1	9.143 106
Cork Rings	8 cm	10	9.143 003
Cork Rings	11 cm	10	9.143 006
Cork Rings	14 cm	10	9.143 009
Coverglass	20x20	1 Pack.	9.161 020
Doser Capillaries	10 ul	10	9.020 190
Draining Rack	-	2	9.003 031
Extraction Cartridge	100 ml	25	9.043 903
Extraction Cartridge	250 ml	25	9.043 905
Extraction Cartridge	500 ml	25	9.043 906
Extraction Cartridge	1000 ml	25	9.043 907
Filterpaper 597	120 mm round	500	9.062 412
Filterpaper 604	120 mm round	500	9.062 912
Filtration Stand	for two funnels	2	9.069 922
Fire Extinguisher	-	2	9.006 908
First Aid Kit	1	-	-
Gas Tube	-	2 m	9.018 970
Gukos	-	2 sets	9.052 400
Herbie Tube clip	M	10	9.207 727
Herbie Tube clip	N	10	9.207 727
Herbie Tube clip	Q	10	9.207 735
Herbie Tube clip	R	10	9.207 738
KECK-Adapter KA	-	10	9.208 930
KECK-Adapter KA	-	10	9.208 931
KECK-Adapter KA	-	10	9.208 940
KECK-Adapter KA	-	10	9.208 941
KECK-tube clamps	KT 4.5	4.5 mm	9.205 904
KECK-tube clamps	KT 6	6.0 mm	9.205 906
KECK-tube clamps	KT 10	10.0 mm	9.205 910
KECK-tube clamps	KT 14	14.0 mm	9.205 914
Lab Jack	110	2	9.117 110
Lab Jack	115	2	9.117 115
Lupe	10x	1	9.151 010
Makrocuvettes	10 mm	4	9.144 210
Manometer	-	1	9.155 006
Microdoser Tube Capillary	-	10	Desaga 13

File: Lab. miscel.
Report: Lab. miscel.

ITEM	SIZE	QUANTITY	Cat. Nr.
Mikrodoser Syringe	10 ul	2	Desaga 13
Mikrodoser Syringe	50 ul	2	Desaga 13
Mikrodoser Syringe	100 ul	2	Desaga 13
Mikrodoser Syringe	250 ul	2	Desaga 13
Mikrodoser Syringe	500 ul	2	Desaga 13
Mortar	125 mm	2	9.164 212
Pestle	125	2	9.164 312
pH-Paper	1-14	2	9.130 210
Pipette Basket	650 mm	1	9.273 985
Pipette Stand	-	1	9.273 894
Pipette Wash Stand	-	1	9.273 955
Pipetting Ball	-	2	9.273 836
Plastic Bottle	10 l	2	9.002 712
Pressure Reducer	for Nitrogen	2	9.223 741
Protective Goggles	-	2	9.005 163
Rubberhats	transparent	20	9.072 681
Separation flask holder	-	10	9.203 410
Slides	-	1 Pack.	9.161 110
Spatulas	180 mm	2	9.150 318
Spatulas	3x130 mm	2	9.220 213
Spatulas	9x185 mm	2	9.220 018
Spraybox for TLC	-	1	9.020 031
Sprayer	-	2	9.024 000
Sprayer	6 ml	4	9.023 994
Sprayer	12 ml	4	9.023 990
Sprayer top-piece	-	2	9.223 111
Sprayer top-piece	-	10	9.223 112
Spraying Bottle	100 ml	2	9.072 748
Spraying Bottle	250 ml	6	9.072 750
Spraying Bottle	500 ml	4	9.072 752
Stand	800 mm	4	9.224 032
Stand rods	1250 mm	10	9.225 241
Stirring bars	10x3 mm	6	9.197 507
Stirring bars	11x6 mm	6	9.197 510
Stirring bars	20x6 mm	6	9.197 520
Stirring bars	35x15 mm	2	9.197 593
Stirring bars	65x20 mm	2	9.197 596
Stopper	14/23	10	9.230 114
Stopper	29/32	20	9.230 129
Stopwatch	-	1	9.262 005
Tecluburner	-	1	9.018 293
Teflon tube	1.5x0.3 mm	2 m	9.205 630
Test tube holder	-	4	9.193 992
Test tube stand	for 24 tubes	2	9.193 124
Thermometer	-10...+250 C	2	9.235 265
Tube connections	8-9 mm	2	9.207 207
Twisers	160 mm	1	9.171 016
Twisers	200 mm	1	9.171 020
Universal Stand Clamp	-	6	9.224 502
Universal Stand Clamp	-	6	9.224 500

File: Lab. miscel.
Report: Lab. miscel.

ITEM	SIZE	QUANTITY	Cat. Nr.
Universal Stencil	200x200 mm	1	9.020 131
Vaccuum Tube	-	10 m	9.205 806
Water tubes Rubber	8x2.0 mm	10 m	9.205 184
Water tubes Silicon	6x1.5 mm	15 m	9.205 273

File: Lab. Tools
Report: June 7, 1988

ITEM	QUANTITY
Allen Wrench	set of 12
Combi Pliers	1
Cutting Pliers	1
Monkey-wrench	1
Pozidriv screwdriver	4 diff. size
Screwdriver	set of 12
Sodering Iron	1
Sodering suction pump	1
Spanner (small)	set of 16
Spanner medium and big	set of 17
Voltmeter	1
Water Tube Pliers	1