OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as "developed", "industrialized" and "developing" are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

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

XD9700098

54 p.
tables
diagrams
illus.
maps

21660

Distr.
RESTRICTED

ISED/R.70
23 September 1996

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

ORIGINAL: ENGLISH

PREPARATORY ASSISTANCE ON THE ESTABLISHMENT OF RESEARCH AND DEVELOPMENT, TRAINING AND INFORMATION CENTRE FOR PROCESSING OF MEDICINAL AND AROMATIC PLANTS

UC/IRA/95/161/11-51

ISLAMIC REPUBLIC OF IRAN

Technical report: Preparatory assistance *

Prepared for the Government of Islamic Republic of Iran
by the United Nations Industrial Development Organization

Based on the work of K.H.C. Baser
Consultant in R & D, processing and quality assessment of
medicinal and aromatic plants

Project Manager: T. De Silva.
Chemical Industries Branch

* The designations employed and the presentation of material in this document do not imply the expression of any opinion of the secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area of its authorities, or concerning the delimination of its frontiers or boundaries. This document has not been edited.

V.96-86111

TABLE OF CONTENTS

Abstract

Upon request by the Islamic Republic of Iran, UNIDO developed a project no. UC/IRA/95/161 titled "Preparatory Assistance on the Establishment of Research and Development, Training and Information Centre for Processing Medicinal and Aromatic Plants" and sent a consultant to Iran to provide advice on the establishment of the Centre.

The consultant visited Iran from 16 July to 4 August 1996 and successfully carried out the duties as described in the job description (Annex 1).

The programme concerning places and institutions to visit was drawn up by the host institution, The Faculty of Science and Medicinal Plant Research Centre of the Shahid Behesti University in Tehran. Some modifications were requested by the mission and some of them were placed in the programme. The work programme of the consultant as scheduled by host authorities is annexed (Annex 2). The persons contacted during the mission are given in Annex 3.

Iran has a rich and diverse flora with the number of flowering plant species estimated as 10,000. She is home to numerous medicinal and aromatic plants, most being endemic species. Flora of Iran has not yet been fully documented but the taxonomic information is almost concise. The country has a culture and tradition of cultivating medicinal and aromatic plants, and several essential oils and extracts are produced for commercial formulations or exported by several companies.

Various departments of the Faculty of Science of the Shahid Beheshti University, Research Institute of Forests and Rangelands (RIFR), Ministry of Industry and private companies such as GTB Group of Companies and Golchekan in Kashan, Pad Shiraz in Shiraz and Kandelous Co. in Kandelous near Chalus were visited. Some lectures were given in universities, and building plans of the Medicinal Plant Research Centre were discussed with the architects and engineers.

The consultant made recommendations on the organizational set up of the centre, its departments, subdepartments, their functions and staff structure. The facilities required for each department were listed. Advice was given on the qualifications of the director and the centre was recommended to be directly linked with the University President's office in order to minimize bureaucracy and to give it more flexibility.

Based on these recommendations, a project should be developed and it should better be executed by UNIDO. The reasons for UNIDO's execution were discussed.

1. INTRODUCTION

1.1 Brief Information on Iran

Iran which is located in the south west part of Asia has a land area of 1.636.000 square kilometers. It stretches between the Caspian sea in the north, and the Persian Gulf and Sea of Oman in the south. Countries neighbouring Iran, clockwise, are Turkmenistan, Afghanistan, Pakistan, Iraq, Turkey, Armenia and Azerbaijan (Map 1 - Annex 4). 11% of the country is covered by forests and scrubland, and 26.9% of the land is pasture and meadowland. 9.2% of the land is under cultivation. 52.9% of the country is covered by deserts or land with no use.

The heartland of Iran lies in the central plateau between the Elbruz and the Zagros mountains on the west and south, and the lowland drainage areas adjacent to Afghan and Pakistan borders in the east. Much of the central plateau is salt and sand desert. Fertile areas with adequate water supply lie in areas such as Isfahan basin, northern Khorasan, and the Qazvin and Varamin plains. The Caspian coastlands and the slopes of the Elbruz mountains in the north receive 1,000-1,200 mm of rainfall on average each year, and natural pasture and forest exist over wide areas of this region.

The population of Iran is estimated to be over 61.2 million (mid-1994 estimate). Annual population growth rate is high (2.7%) and the population density is around 37 per sq.km. Life expectancy in 1992 was 66.6 year according to UNDP's Human Development Report. 57% of Iranians are urban dwellers.

Iran has 24 provinces (Osthans). Since 1979, the country has become and islamic republic by adopting an islamic constitution based on the ideas of Ayatollah Khomeini, which ended the division of religious and secular rule.

Oil and services together contributed to 58% of Gross Domestic Product (GDP) in 1992. The same year, the share of agriculture in GDP was 23.3% while manufacturing and mines was 19.7% [1].

The national currency of Iran is Rial (IR) and IR10=1 toman. The official exchange rate of IR was IR 3000 = US$ 1 in July 1996.

1.2 The Flora of Iran

Iran is under the influence of four phytogeographical regions and is considered as the centre of origin of many genetic resources of the world. The richness of biodiversity in the country is influenced by its climate (from alpine to sub-tropical), land form, soil, altitude (from sea level to 5770 meters) and geological formation. Almost any genus existing in alpine to sub-tropical biomes of the world can be found in Iran. Phytogeographical regions of Iran are as follows:

1. Euro-Siberian (Euxino- Hyrcanian province)
2. Irano-Turanian (Irano-Anatolian province)
3. Sudano-Zambezian (Nubo-Sindian province)
4. Saharo-Arabian (East Saharo-Arabian sub-region)

[1] Iran: country profile (1994-1995), The Economist Intelligence Unit, London (1994)

Irano-Turanian region covers over 70% of the country. Sudano-Zambezian and Saharo-Arabian regions cover 26% and the Euro-Siberian region covers 3% of Iran. Irano-Turanian region is rich in endemic plant species. The Hyrcanian district (in Pontic Province) is home to relic species of the Tertiary era. Sub-tropical species thrive in the Saharo-Sindian region in the south[2] (Map 2 - Annex 5)).

In Iran, today there are seventy seven protected areas including seven national parks, four national nature monuments, twenty-four wildlife refuges and fourty-two protected areas which cover approximately eight million hectares. There are also fifteen natural forest parks and sixty-four forest reserves. These areas which are under the supervision of the Forests and Rangelands Organization under the Ministry of Jahad Sazandegi were created to help conserving biodiversity in the country.

Although the flora of Iran has not yet been fully documented, the number of species in the flora of Iran is estimated to be between 7.000 to 10.000. The important books on the flora of Iran are listed in Annex 6.

2. VISITS TO INSTITUTIONS

2.1 Shahid Beheshti University

Shahid Beheshti University (SBU) is one of the largest universities in the Islamic Republic of Iran. The University was established in 1959 as a private university in northern part of Tehran in a campus on the outskirts of the Elbruz mountain under the name of the National University of Iran. In 1960, the establishment of this university was approved by the government. After the revolution in 1979, the university acquired its new name. The University has, at present, twelve Faculties including Medicine, Science, Architecture, Law, Economics, Literature, Electronic and Mechanical Engineering, Computer Science, Mathematics, and Geology, and is engaged in 50 areas of studies. The number of students studying in the university are as follows: around 9000 undergraduate, 2000 MSc and 120 PhD 420 academic staff serve in the university of which 250 are PhD degree holders, the rest have MSc degrees. These eminent scholars are involved in teaching both at the undergraduate and graduate levels as well as in research activities. The University has a Central Services and Maintenance Department which provide repair and maintenance work to the requesting faculties or departments. Main Library of the University has 300.000 volumes of books in its holdings. Ca.70.000 of which are on chemistry and about 2500 are on biology including botany. The Library receives 500 journals in English and 100 journals in Persian. 30 of the journals in English are on Chemistry, and 27 journals are on biology. Important abstracting journals such as Chemical Abstracts are available as full collection since its first issue published in 1907. Cumulative Indexes are also available until 1966. A complete set of Biological Abstracts is also present in the Library. In addition Current Contents-Life Sciences is also regularly received. Fully computerized borrowing or on-line linkages to databases are not yet available in the Library. However, the library is quite impressive as far as its holdings in chemistry and biology are concerned. It was not encouraging to hear that several of the journals had been discontinued as the annexed list implies (Annexes 7 and 8).

Since the Medicinal Plant Research Centre (MPRC) is under the Faculty of Science, a closer focus will be made to this faculty.

---

[2] M. Makhdoum, B. Darreh-Shoori, B.H. Kiabi, H. Majnounian and B. Zehzad, Biodiversity Conservation and Management of protected Areas, report, Tehran (1994)

2.1.1 Faculty of Science

The Faculty of Science is one of the oldest and the best equipped faculties of the university. It was founded in 1963. The Faculty has 400 undergraduate, 50 M.Sc. and 20 Ph.D. students. Seven graduate students of the faculty are doing their Ph.D. studies in another university. It consists of the following departments and research centres: Departments of Biology, Chemistry and Physics, and Medicinal Plant Research Centre and Laser Research Centre.

The Chemistry Department has an academic staff of 44 of which 22 hold a PhD degree. There are five professors, one associate professor and sixteen assistant professors. Eighteen staff members with MSc degrees and five staff members with BSc degrees work as research assistants. The Chemistry Department is said to be the best department of chemistry in Iran for every year its graduates comprise the majority of chemists leading to a higher degree in Iran Universities. The department has modern educational and research facilities and has a library which is endowed with journals and books in chemistry. The Department has a central instrumentation facility containing the following instruments: Analytical High Pressure Liquid Chromatography System: Shimadzu LC-6A with two pumps, UV/VIS detector (SPD-6AV), system controller (SCL-6A), integrator (CR4A); Preparative High Pressure Liquid Chromatography Systems (2 pcs): (1) Varian 8500 with two pumps, UV/VIS detector (Varichrom), recorder (Varian Model 9176) and integrator (Varian Model CDS 111), (2) Waters System 500. Only the refractive index detector of this system is presently being used with the Varian semi-preparative LC system; Rotary Locular Counter Current Chromatography System: Eyela with pump (Eyela UP-60) and UV/VIS detector (Eyela UV-9000). The equipment was said to be not used routinely; Gas chromatographs (2 pcs): (1) Perkin-Elmer F30 suitable for packed columns, two injection ports, two FID detectors, hydrogen generator (General Electric) and nitrogen used as carrier gas. (2) Perkin-Elmer Sigma 1 suitable for packed columns, with integrator, two injection ports, FID and TCD detectors, hydrogen generator (GE), helium and nitrogen as carrier gas for use with TCD and ID detectors, respectively; Gas Chromatography/Mass Spectrometry Systems (2 pcs): (1) Shimadzu GC/MS QP1100EX with GC4A and quadrupole MS measuring up to 1100 m.u., suitable for use with packed and capillary columns, with EI/CI (isobutane, methane and ammonia) functions, Shimadzu CR5A integrator, Epson FP-1050 recorder, Acer computer (486SX, 33 MHz, 4MB Ram/1.2 GB hard disc, CD Rom drive), hydrogen generator (Shimadzu OPGU-1500S), helium as carrier gas, Wiley (85.000 MS) and NBS (65.000 MS) computerized libraries. (2) Varian 1400 Gas chromatograph coupled with Finnigan Mat 44 quadrupole mass spectrometer measuring up to 1300 m.u. This old instrument is presently being reassembled and, therefore, is out of order; UV/VIS Spectrophotometers (3 pcs): (1) Pye Unicam SP1750, (2) Varian Cary 219, (3) Perkin Elmer 402 (these three equipment were said to be ca. 18 years old); IR Spectrophotometer (2 pcs): (1) Perkin Elmer 599, (2) Perkin Elmer 283 (Both instruments were said to be 16-18 years old); Nuclear Magnetic Resonance Spectroscopy System: Varian 80 MHz FT-NMR measuring proton, carbon-13 and fluorine was assembled three years ago by Dr.Bageri using parts from two NMR equipment broken to pieces after falling from three meters; The Department holds the following Sadtler Spectra Collections with indexes: UV=34084 spectra, IR= 65000 spectra, 1H-NMR= 38500 spectra; Fluorescence Spectrophotometer: Perkin Elmer MPF-44 (ca. 18 years old); Atomic Absorption Spectrophotometers (2 pcs): (1) Perkin Elmer 560 with hydride generation system for mercury and arsenic, (2) Perkin Elmer 503 with graphite furnace; X-Ray Spectrometer: Philips PW1600; X-Ray Diffractometer: Philips PW1130. Both these instruments are said to be 22 years old and both fill a large room. They need to be computerized. [For this reason the following equipment in the Geology Department housed in the same building are used when needed. X-Ray Spectrometer: Philips PW1480 with Philips computer 386SX, 33 MHz, 1/40 MB, samples are bar-code labelled. The instrument was installed three years ago and is in good working condition. X-Ray Diffractometer: Philips PW17. The instrument was installed twelve years ago and is said to be in good condition]. Flame Photometer: Perkin Elmer Coleman 51-Ca; Polarographer: Metrohm E505 Pulse and differential pulse polarographer with Polarecord E506 (Metrohm) recorder. Multichannel Elemental Analysis Apparatus: Ortec Model 6240. This equipment is being repaired. The other equipment present in the laboratory are as follows: Microwave oven (National IEC-705, 700W), Kjeldahl Apparatus (Iranian made), pH-Meters (3 pcs): (1) Metrohm E516, (2) Fisher-Accumet digital pH-Ion Meter (2 pcs); Analytical Balances

(3 pcs): (1) Mettler H30, (2) Mettler H51, (3) Sartorius; Stereomicroscopes (3 pcs): Wild, Zeiss and Nikon; Water Distillation Stills (2 pcs): One is Heraeus, each 6 L/h; Laboratory Presses (2 pcs): (1) Perkin Elmer for IR, (2) Paul Weber; Ultrasonic Bath: Fritsch; Refrigerator (General Electric); Muffle Furnace: Demerd (Iran) up to 1100°C; Drying Oven: Heraeus, up to 240°C; Laboratory Hoods (3 pcs): Locally made; Hot Plate (Fried Electric-Israel), Water Bath (Memmert -Hakimian); Melting Point Determination Apparatus: Mettler FP5; Bench Centrifuge: Clinical Instruments (Iran); Computer: IBM 286, 1/40 MB is used for office work.

In some other laboratories of the Chemistry Department the following important equipment were seen: Atomic Absorption Spectrophotometer: (1) Shimadzu AA-680 with autosampler (being repaired), (2) Varian Techtron AA-5 (being repaired); IR Spectrophotometer: Shimadzu IR-470; UV-Spectrophotometer: Shimadzu UV-2100; Gas Chromatograph: Varian Series 1400 with Philips recorder.

The Library of the Faculty of Science gives service to the departments of Chemistry, Physics, Mathematics and Statistics. The library holds 15.000 volumes of books, of which ca. 4000 are on chemistry. There are also 65 MSc theses. Of the 100 journals currently on display, 30 are on chemistry. Only the latest issues of journals are displayed. When a new issue is received the old issue goes to the main library of the university.

A large volume of research work at the Chemistry Department involves phytochemical studies of medicinal and aromatic plants. A list of plant species on which chemical studies have been conducted and published is annexed (Annex 9).

The Biology Department has a staff strength of 26 comprising 14 PhD and 12 MSc degree holders. There are no professors in the Department. There is one Associate Professor and the rest are assistants. The department has no PhD programme. MSc programmes are held in four major fields: Botany, Microbiology, Genetics, Animal Physiology and Embriology with a total of 30 students. 400 undergraduate students lead to a BSc degree in Biology. The Herbarium contains about 25000 mounted specimens. The Departmental Library has 4500 books and 100 theses in its holdings. The latest issues of 27 journals on biology are displayed in the library. There is room for improvement for the botanical books and floras.

The Medicinal Plant Research Centre (MPRC), established in 1993, will be housed on one of the two wings of the new futuristic looking building to be constructed together with the Laser Research Centre. According to a flow chart given to the consultant, the Centre is administered by a Director who is also the Dean of the Faculty of Science. He is helped by a Chairman, and a local consultant. The Centre consists of the following Departments and sub-departments. These departments are currently operating within the Departments of Biology and Chemistry of the Faculty of Science, and the Faculty of Medicine.

The Phytochemistry Department consists of the following laboratories: Chemistry Laboratory to conduct extraction, isolation, chemical studies and stability studies; Analytical Laboratory controls the Instrument Laboratory, and is charged with quality control studies; Taxonomy and Pharmacognosy Laboratory is planned to be engaged in identification of plants, purity assessments for plant drugs and preparation of monographs. The department has seven staff members of which four has PhD, and 3 has MSc degrees.

The Phytochemistry Department has been very successful and fruitful in producing scientific papers and running degree courses for PhD and MSc over the last twenty years under the able leadership and expert guidance of Prof.A.Rustaiyan. The department is engaged in research into studying the chemical compositions of medicinal and aromatic plants of the flora of Iran by extraction/distillation, isolation, purification and structure elucidation. Research interests of the department have specifically lied on the study of sesquiterpene lactons, essential oils and flavonoids in plant species belonging mainly to the families of Compositae, Labiatae, Umbelliferae and Rutaceae. Those plant species endemic in Iran were given priority in research programmes. The department has published 93 research papers since 1975. Four

of these papers were on non-plant chemistry. Eight of the papers were reviews on Iranian plant constituents. Seventy of the papers were on chemical constituents isolated and characterized from fifty three Iranian plant species. Seventy two of the papers were published in international peer-reviewed journals and forty two papers appeared in Phytochemistry. The department has published eleven papers on the essential oil constituents of Iranian aromatic plants, namely, Artemisia aucheri, A.haussknechtii, A.santolina, A.sieberi, Nepeta denudata, N.glomerulosa, N.laxiflora, Mentha mozaffariani, Myrtus communis, Pulicaria gnaphalodes, Zhumeria majdae. A comprehensive list of all the plants whose constituents have been reported is given in Annex 9.

The wet laboratory of the Phytochemistry Department is housed within the Chemistry Department. It has a TLC Plate spreader (Camag), Rotary evaporators (3 pcs): Eyela and a local-make (2 pcs), Clevenger Type Essential Oil Distillation Apparata (3 pcs), Drying Oven (Fisher Model 349), Balance (Ohaus, up to 20 kg), Analytical Balance (2 pcs): Sartorius (top loading) and Oertling 30TD, Heating Mantles (5 pcs), UV Viewing Lamp (2 pcs): Desaga, TLC Plate Heater (Camag) (4 pcs), Fridge, Freezer, Vacuum pumps (2 pcs), Water Vacuum Pump (Rikakikai), Laboratory Hood, HPLC System: Knauer with two pumps and RI detector.

Biological Evaluation Department consists of an Animal House and two laboratories: Pharmacology Laboratory is planned to conduct biological activity screening, toxicity tests, and bioassays; Microbiology Laboratory to conduct antibacterial activity testing and bioassays. The department has five staff members of which three has PhD, and two has MSc degrees. Only one member of the group is a pharmacologist with PhD who is the head of the Pharmacology Department at the Faculty of Medicine.

The Pharmacology Laboratory is situated on the top floor of the Faculty of Medicine. The department was established 32 years ago and had only one academic staff during this time. Six years ago the department underwent renovation and acquired modern research facilities and staff members. The department has 10 PhD holders of which three are associate professors and seven are assistant professors. There are twelve students doing PhD. Eleven of them are pharmacists and one is a medical doctor. The department is engaged in research into neuropharmacology including analgesic, antiepileptic, antiseizure activities, and learning/memory behaviour, cardiovascular system activities. In addition, bioequivalency studies are carried out for drug companies using voluntary human subjects in testing the kinetics of drugs in human body by comparing the activities of the drug tested with a known drug with the same activity. Each year, 2-3 drugs are tested with a return of 1 million toman per drug (ca. $3000) to the department.

The department has the following major equipment: Microdialysis equipment for the measurement of neurotransmitters in brain. High Pressure Liquid Chromatography (HPLC) System (Shimadzu) with electrochemical, fluorescence, refractive index and UV/VIS detectors and a Chromatopac (Shimadzu, C-R4A) integrator. Another HPLC System (Shimadzu, LC-6A) is used only for bioequivalency studies and consists of system controller, autoinjector, column oven, UV/VIS detector and two pumps. For epilepsy studies, an electical kindling model is used whereby 50 micron to 500 micron current is applied into the brain of the animal through an electrod during a span of 18 to 20 days with one stimulation a day. Once epilepsy is formed then antiepileptic drugs are tested on this model by constantly measuring the EEC of the test animal. A Grass 88 Stimulator with a constant current unit is used with Narcotrace recorder. Two channel osciloscope is used to calibrate the biphasic current. A Stereotaxic instrument is used for implanting electrodes in the brain of an animal. In the animal behaviour observation laboratory, Tail Flick Analgesia Test equipment (Hugo Sach Electronic), and formalin test are used for testing analgesic activity. There are also Rotarod Treadmill for mice, computer controlled Activity Monitoring Set-up (Columbus Instruments) and 16-channel Isothermex instrument for measuring body temperature. For cardiovascular studies, Atrial/Ventricular (A/V) nodes of the heart are stimulated (at atrial) using a computer-controlled electrical stimulation system and the results (measured from the ventricular) are recorded by a 4-channel recorder (Narco-Biosystems).

Since two years, the work on medicinal plants has been in progress in the department. Hot and cold water, and methanolic extracts of four plants have been tested for analgesic, antiinflammatory and antiepileptic activities. Their LD50 values are also determined in mice to assess toxicity and to determine the administration of the best dose level. The plants under investigation are the following: Sambucus nigra, Trigonella foenum-graecum, Elaeagnus angustifolia and Cuminum cyminum. The department is collaborating with the Botany and the Phytochemistry Departments in the work with medicinal plants. The departmental library has about 300 basic books on pharmacology, however, is desperately in need of journals. MedLine on CD-ROM and Current Contents-Life Sciences on diskettes are available in the Faculty and Main Library, respectively.

The Microbiology Laboratory is situated in the building housing the Biology Department of the Faculty of Science. The department has three staff members with one PhD and two MScs. In collaboration with the Phytochemistry Department, antimicrobial activity testing of 33 alcoholic plant extracts and essential oils from plants belonging to compositae, labiatae and umbelliferae families were carried out . The microorganisms used in the tests included aerobic bacteria, gram positives, gram negatives, enterobacteria, pseudomonas, staphylococci, streptococci, etc. Most extracts were found effective against gram positive bacteria, especially Staphylococcus strains which are pathogenic. 8 extracts showed significant antibacterial activity and the activities of three extracts were outstanding. When fractionated by column chromatography, these extracts showed activity in the diethylether and n-hexane eluates containing terpenoids. The department is implementing two research projects with grants from the Research Fund of the university jointly with the Botany and the Phytochemistry Departments. These are: (1) Study of the antimicrobial activity and identification of the effective substances present in the extracts and essential oils of the Iranian medicinal plants (1992). Researchers: F.Eftekhar*, A.Rustaiyan, B.Zehzad, D.Azizian and F.Shimi. (2) Selection of optimum extraction conditions for terpenoids with known molecular structure from native Iranian plants and study of their biological effects. Researchers: A.Rustaiyan* and F.Eftekhar. (* represents principal researcher).

A list of native plants used for the study of antimicrobial activity is annexed (Annex 10).

Mycology Laboratory is also situated in the Department of Biology. Work is in progress on the production of mushroom spawns, systematics of cyanobacteria, fungi, green, brown and red algae. Dr.Riahi, head, is collaborating with Prof.Rustaiyan for the development of a suitable extraction technique for beta-carotene from the salty water in which the micro algae Dunaliella salina, discovered by him in Urumiya Lake, gives of a red dye. The micro algae which is green in normal water turns red in salty water and stains it. It is hoped to manufacture beta-carotene by its cultivation.

The Biology Department has necessary autoclaves, incubators, laminar flow cabinets, refrigerators, freezer, drying ovens, sterilizers, microscopes (stereo, research, fluorescence), water baths, microtomes, amino acid analyzer, centrifuges, refrigerated centrifuge, microcentrifuge, ultracentrifuge, gel electrophoresis equipment (Agarose gel, Western Blot, flat bed), water distillation apparata for research. The department also has an animal house facility. Mice, rats, rabbits and frogs are kept in an annex to the main building. The animals are kept in polypropylene cages (16 large, 100 small) and stainless steel dog cages. A sterile work chamber and two operating benches are also present.

Agronomy Department does not have any agronomist among its staff members. It should better be called Botany Department since all the members of staff assigned to work in this department are botanists. Four out of five staff members have PhD degrees and one taxonomist has a DES from France. The department manages a herbarium with ca. 25.000 specimens and a green house. Research work include plant taxonomy, ecophysiology, cytogenetics, palinology, micropropagation, tissue culture, collection of ethnobotanical data, ecological data collection, conservation of medicinal plants, etc. Twelve postgraduate students are studying for MSc degree. The department is one of the important centres contributing to the taxonomic study of the flora of Iran coordinated in the Jahad Sazandegi Botanic Garden. Research facilities

include research and stereo microscopes, CO2 incubator, incubators, centrifuges, autoclaves, electrophoresis equipment (Agarose gel and Western blot), shakers, water baths, UV spectrophotometers, balances, shaker baths, laminar flow cabinets, Kjeldahl apparatus, a phytotron for tissue culture work.

Process Technology Department consists of Pilot Plant Unit and Formulation Unit. The Department is represented by three chemical engineers of which one has PhD and two have MSc degrees. The PhD degree holder Dr.(Ms.) Maleki Moghadam has experience in spectroscopy. Mr.Saddek Tarverdi has 15 years of experience in chemical engineering. He had served as Head of the Chemical Engineering Group and Director of Chemical Process Centre in Jahad Daneshgahi. Jahad Daneshgahi is an industrial research institution operating inside some universities. The branch in SBU was reported to be dealing with medicinal and aromatic plants. Mr.Tarverdi gave an account of the research projects he was involved in on medicinal and aromatic plants while working in Jahad Daneshgahi. According to his account, they were (1) Extraction of caffeine from tea wastes. This project was implemented jointly with Dr.A.Shaabani, Chairman of the Medicinal Plant Research Centre, then a researcher in Jahad Daneshgahi. In a 200 L pilot plant 10 kg of caffeine was reportedly produced. The project has not been commercialized. (2) Extraction of tannic acid from Oak Gall. Technology was developed using a pilot plant and 5 kg tannic acid was produced. The know how and plant design were sold to a local entrepreneur who is now constructing the plant in Ilam, near Iraq. (3) Distillation of turpentine oil from Saakez gum ex Pistacia atlantica (Banee in Farsi). Lab scale work was carried out to distil the oil from oleogummiresina. The oil contained 80% alpha and beta-pinenes. They were converted to terpineol. This project has also not been scaled up to commercial production. (4) Extraction of pyrethrinoids from Chrysanthemum cinerariefolium. This is an ongoing project. The plant has been cultivated in 5 ha and the yield of pyrethrins from dry flowers was <2%. A pilot plant with 300 L capacity has been manufactured for scale up studies. Mr.Tarverdi indicated his strong wish to work with a multipurpose pilot plant. Information about a 500 L capacity multipurpose pilot plant was provided to him.

Library and Information Unit is planned to have a so-called Database Computer Control Unit and is thought to collate industrial information and to publish a newsletter. At present, there is no facility, no staff, and no activity in this unit.

2.1.3 Meeting with the President of the University

A meeting was held with the President of the University also attended by the Director and the Chairman of the Centre. The meeting lasted for almost 1.5 hours in a cordial atmosphere. The President, Prof.Dr.Nadimi, gave assurances that the University as well as the Government were committed to strengthen the Centre. He promised his strong support to develop the Centre to enable it tap the potential of rich medicinal and aromatic plant wealth of Iran. He expressed his willingness to employ young scientists as full time staff of the Centre, and indicated his wish to do everything possible to offer them the best training opportunities. He also expressed his desire to closely cooperate with UNIDO in the execution of the project. He agreed with the Consultant that the Centre should be a focal point of all activities in the University with regard to medicinal and aromatic plants serving as a central research facility to related researchers in the Faculty of Science and other faculties and departments, and that it should cooperate with other similar research institutions in Iran and abroad to enlarge and diversify research activities, thereby improving research and development capabilities.

2.1.4 The Building

The Medicinal Plant Research Centre and the Laser Research Centre will be housed in a building to be constructed on a hill overlooking the campus with a good clear view of the city (Annex 17). The building was designed by Mahir and Associates Co. who is the contractor of the project. The company has subcontracted the construction work to Zaminesaz Co. The Office of Construction Works of the University is the controller of the project and is also provide consulting services to the contractor company. According to the information given by Mr.Saeed Gharari, Civil Engineer in the University Office, the project

was protected by law and was enjoying the particular interest of the Office of the President of the Islamic Republic of Iran. He acknowledged UNIDO's interest and support in the improvement of the building plans and expressed his desire for UNIDO's continuing support during the implementation stages of the project.

A meeting was held with the architectures of the project and advice was given especially on the pilot plant section and its utilities on the layout plan of the building.

2.2 Research Institute of Forests and Rangelands (RIFR)

Research Institute of Forests and Rangelands (RIFR) was established in 1968 to carry out research into various aspects of forests, rangelands, soil conservation and watershed management and moving sand dune fixation. Following the Islamic Revolution, the National Botanical Institute and the National Botanical Garden was also affiliated to RIFR. Since 1990, the institute is under the Ministry of Jahad Sazandegi (meaning holy war for construction). RIFR has the following ten research divisions: (1) Forestry Research Division, (2) Poplar and Fast Growing Trees Research Division, (3) Wood and Paper Science and Technology Research Division, (4) Range Research Division, (5) Forest and Range Protection Research Division, (6) Botany Research Division, (7) Soil Conservation and Watershed Management Research Division, (8) Combatting Against Desertification and Sand-Dune Fixation Research Division, (9) Genetic and Plant Physiology Research Division and (10) Medicinal Plants and By Products Research Division. The headquarters of RIFR is in Karaj about 20 km out of Tehran. The institute has 28 regional branch institutes in 25 provinces of Iran. The total staff strength of RIFR is 630 researchers including 200 M.Sc. and Ph.D. holders. The institute presently handles about 730 projects, of which 98 are on medicinal and aromatic plants. Medicinal Plants and By Products Research Division was founded in 1989 to perform collection, identification, domestication and analysis of the medicinal and aromatic plants of Iran. An UNDP/FAO project No. IRA/89/030 titled "Enhancing the Research Development and Capabilities in Aromatic Plants" aimed at strengthening the facilities and capabilities of RIFR by the establishment of a Plant Sciences Laboratory to carry out research into aromatic plants of Iran for the production of essential oils was launched in 1991. Project activities started in 1993 and were completed recently. The project budget was to the tune of $ 330.000, $250.000 coming from UNDP IPF for Iran. The project was executed by FAO and the implementing agency was RIFR. The Phytochemistry Laboratory established as a result of this project has two bench-top all glass steam distillation set-up. These apparata are modified simple distillation apparata, whereby between the condenser and the distillation flask a glass part containing plant material is placed. Water is boiled in the distillation flask and the steam generated runs through the bottom of the body of plant material. One drawback of these apparata is that some steam condensing on the plant material returns to the distillation flask after extracting water solubles from the plant. This may result in the production of artefacts. The technique can best be likened to the "water and steam distillation" units used by cottage industries. Apart from an Atomic Absorption Spectrophotometer and an UV/VIS Spectrophotometer (both Hitachi), the Unit has a gas chromatograph (Shimadzu GC-9A) using polar and non-polar fused silica capillary columns (DB-1 and DB-Wax), and a Gas Chromatography/Mass Spectrometry (GC/MS) System (Varian 3400 GC + Varian Saturn II Ion Trap Detector MS) using DB-5 medium polarity fused silica capillary column. The system has the following libraries: Wiley (140.000 compounds), NIST (54.000), Pesticides (525), Libr(tp) (Adams) (500), and own library containing MS of 100 standard compounds. Kovats Indices of each compound detected is checked for identification. The Unit has completed the distillation and analysis of the following essential oil bearing plants: Artemisia sieberi (Compositae), A.dracunculus (Compositae), Bunium persicum (Umbelliferae), Chenopodium botrys (Chenopodiaceae), Cinnamomum zeylanicum (Lauraceae), Cymbopogon olivieri (Graminae), Dracocephalum moldavica (Labiatae), Ducrosia anethifolia (Umbelliferae), Dorema ammoniacum (Umbelliferae), Echinophora platyloba (Umbelliferae), Eleagnus angustifolia (Eleagnaceae), Ferula gummosa (Umbelliferae), Heracleum persicum (Leaves) (Umbelliferae), Heracleum persicum (seeds) (Umbelliferae), Hypericum perforatum (Hypericaceae), Hyssopus officinalis (Labiatae), Jasminum humilis (Oleaceae), Lavandula angustifolia (Labiatae), Lawsonia inermis (Lythraceae), Lonicera caprifolium (Caprifoliaceae), Lomatopodium staurophyllum (Umbelliferae), Melissa officinalis (Labiatae), Mentha pulegium, M. spicata

(Labiatae), Nepeta menthoides (Labiatae), Nigella sativa (Ranunculaceae), Perovskia abrotanoides (Labiatae), Pulicaria dysenterica (Compositae), Pistacia atlantica, P. kurdica, P. mutica (Anacardiaceae), Robinia pseudoacacia (Leguminosae), Rosa damascena (Rosaceae), Salix aegyptica, S.macrosiphon, S.lerifolia (Labiatae), Stachys lavandulifolia (Labiatae), Spartium junceum (Leguminosae), Tanacetum balsamita (Compositae), Zataria multiflora (Labiatae), Ziziphora clinopodioides, Z.tenuior (Labiatae).

The Medicinal Plants and By Products Division is the department responsible for research into medicinal and aromatic plants with special emphasis to their identification in the wild and studies for their introduction in the botanic garden and for their domestication, and phytochemical analysis. 500 sq.m. experimental plots have been allocated for domestication studies. The work of the institute has been mainly on screening a number of aromatic plants for their essential oil content and composition. The division has laboratories in six other branch institutes. These branch laboratories were said to perform phytochemical screening studies.

The Herbarium (TARI) was established 24 years ago. It is considered as the Central Herbarium of Iran and the Flora of Iran is being prepared and published in fascicles each covering one family. The Herbarium is well maintained by ten specialists and it contains 125.000 specimens covering 7000 species. As the Flora of Iran is estimated to have between 7.000 to 10.000 species, the collection of Iranian plants in the Herbarium is quite comprehensive. The Herbarium has contributed to the flora of Iran with the introduction of 150 new species and 200 new records in the past 24 years. The Iranian Journal of Botany is published by the Herbarium.

The Botanic Garden was established in 1968. It covers an area of about 150 hectares. The garden is also named National Botanical Garden. The construction of the garden is still under operation. Several lakes have been created and three hills have been built to represent Elbruz, Zagros and Himalaya mountains. A large rock garden with cliff walls and a water fall has been constructed. An area of about 5 ha represents the Caspian forest. A section for desert plants with sand dunes, a salt lake, and a valley have been created. Medicinal plants, bulbous plants, fruit trees will be grown in separate sections. The garden presently has about 3000 species.

The Library of RIFR keeps more than 4000 books botany and taxonomy and an archives of reprints. It also receives 200 foreign periodicals regularly.

2.3 Kandelous Agricultural Co. in Kandelous

The company has two facilities, one in Chalus and one in Kandelous. The latter factory was visited. The company produces mainly culinary herbs and some essential oils. The plants are cultivated in the company's own fields and are dried, packed and sold in retail outlets. The products are accompanied by colourful brochures which give the user hints on the use of these products. In the factory in Kandelous, air drying on trays, hand-sorting and hand-packaging facilities are available. The factory in Chalus was said to have larger space and, in addition, distillation facility for essential oil production. Main products of the company includes: Cumin seeds, senna, henna, thyme, basil, spearmint, Achillea millefolium, oregano, Sedar (Ziziphus spina-christi), hyssop, marjoram, hawthorn flowers, liquorice, Verbena officinalis, rosemary, nettle, sage, Lavandula vera, Ziziphora, lemon balm, camomile, pennyroyal, myrtle and borage.Mixtures are as follows: Pizza Powder, Sour Tea, Green Tea, Culinary Condiment. The essential oils marketed by Kandelous are the following: Neroli oil, Lime oil, Artemisia oil, Tarragon oil, Fennel seed oil, Geranium oil, Cumin seed oil, Mint oil, Lavender oil, Thyme oil, Orange oil, Rosemary oil, Sage oil, Savory oil, Peppermint oil, Dill weed oil, Rose oil, Pine oil, Eucalyptus oil. The company is also marketing an Aloe Gel and Aloe Cream.

2.4 GTB Group of Companies, Kashan

GTB Group of companies were visited in Kashan. The group is located in the slopes of Karkas mountain about 1800 m from sea level, 44 km west of Kashan in Central Iran. The companies are Golkaran, Taghtiran and Barij Essence.

Golkaran Agro-Industrial Co., established 10 years ago, has 85 ha of cultivation field and 1200 sq.m. manufacturing site. The company also has fields in Kashan (70 ha), Delidjan (10 ha) and Kazerun which is 250 km from Shiraz in Fars province is going to have cultivation fields and a manufacturing unit nearly half that of Golkaran's capacity. The company is engaged in extraction and distillation of medicinal and aromatic plants. The company has a staff strength of 60 agronomists of which four are engineers with MSc degree. The company cultivates ca. 60 plant species for distillation and extraction. Most of them constitute essential oil plants. Total output of Golkaran is 7 tons of oils per year. About half of it is exported while the remaining half is used locally in Iran. Some of these plants and their oils (volume in tons) are as follows: Spearmint (2), Dill (seed + weed) (2), Thymus zygis (wild) (1), Fennel (1), Cumin (1), Galbanum (1), Myrtle (0.5), pennyroyal (0.5), Eucalyptus camaldulensis (0.5), Tarragon (0.5), Artemisia sp.(?) (0.5), Rue (Ruta graveolens) (domesticated) (0.2), Geranium (Pelargonium roseum) (0.1), another Pelargonium sp.(?) (0.04), Hyssop (0.01), Satureja montana (5 kg). Peppermint, Calendula and Aniseeds cultivation had just started. An Ephedra species (?) was domesticated. 20 tons of henna and senna extracts were produced. The company produced 25 kg of rose oil this year. In Kashan area, three factories and 200 shops produce rose water. According to the information given by the managing director, the rose oil stills were used for the production of other oils like spearmint, galbanum, dill, fennel, cumin, etc. after the rose season. The consultant was surprised to hear this since nowhere in Turkey and Bulgaria rose oil distillation plants are used for the distillation of any other oils due to risk of contamination of the highly precious rose oil.

Golkaran has four 5000 L distillation stills, two 1200 L cohobation stills (with 3 m columns packed with ceramic), one 4000 L still for umbelliferae fruits such as fennel and cumin and a 600 L still with top-stirring for galbanum distillation.

Although cultivation and production of products from medicinal and aromatic plants were carried out at the company, the consultant noticed a clear lack of the application of scientific principles both in agricultural and distillation practices. This was a typical example of a company who is in need of professional advice which can be given by an institute or research centre specialized in industrial processing of medicinal and aromatic plants.

Taghtiran Co. fabricates machinery (stills, extractors, chemical reactors, containers, mixers, etc.) and spareparts. The company has a workshop for stainless steel working facilities. Staff strength of the company is 80 including one food technologist (MSc).

The newly established Barij Essence was said to manufacture drugs, concentrated aromatic waters, fragrances, food flavourings, health products using natural extracts and essential oils.

2.5 Golchekan Agro-Industrial Co., Kashan

Golchekan company was established 22 years ago as a joint venture between the Ministry of Agriculture and the Bulgarian Government. Bulgarians had set up the factory and exported the oil to Bulgaria. The company has four 5000 L copper stills and a cohobation still. Distillates from all the stills go to the cohobation still and the final distillate containing rose oil is collected in a large Florentine flask. The factory normally works up 1000 tons of roses a year, but this year only 300 tons of roses were processed. The rose water output of the company was 450.000 liters this year.

The company plans to expand its distillation capacity by additional stills to be housed in a separate building for the distillation of non-rose aromatic plants. Large areas were said to have been reserved for the cultivation of aromatic plants around the factory.

2.6 Pad Shiraz Co., Shiraz

The company has two factories one in Kavar area, south-east of Shiraz near Meymand and another one near Darab, eastern part of Shiraz. The former factory was visited. The factory has two 2000 L stainless steel stills resembling rose oil stills, and a ca. 200 L stainless steel pilot distillation plant. The other factory was said to have four 4000 L stills.

The following oils were said to be produced (volume in tons) in both factories of the company: Zataria multiflora (marketed under the name Origanum) (5), Galbanum (3), Tarragon (3), Golpar (Persian Cow's Parsnip = Heracleum persicum) (2), Thyme (1), Myrtle (1), Cumin (0.5).

2.7 The Meeting at the Ministry of Industry

A meeting was held at the Ministry of Industry with the participation of 33 invited representatives from research institutes, universities, ministries and the private sector under the chairmanship of Mr.Ahmad Ahmadi, Head, UNIDO Coordination Office at the Ministry. Mr.Tuley De Silva, Special Technical Adviser, UNIDO- Vienna and the consultant enlightened the audience on the mandate of the mission and on UNIDO activities around the world concerning industrial utilization of medicinal and aromatic plants.

The meeting endorsed the private sector participants' interest in the necessity to establish a Medicinal Plant Research Centre geared to solve industrial problems of the sector. One private sector participant went ahead to suggest the formation of a special fund by the companies producing medicinal and aromatic plant products as a move to help facilitate the establishment of the centre. A participant from a research institute argued the establishment of a national research centre at a university and proposed its establishment under the Ministry of Health for it to pursue Government policies much better. However, several participants rejected the idea and elaborated that the venue was not important and that the main mandate of the centre should be to contribute to the development of the country by providing applied R&D services to the industry for the development of the sector.

The meeting also gave opportunity to the consultant to meet several participants from companies based in Tehran and Shiraz producing extracts and essential oils from cultivated medicinal and aromatic plants. During the meeting it was brought to the attention of the consultant that there was a Department of Pharmacy at the Medical Faculty of the Shahid Beheshti University. However, it was not possible to arrange a visit or a meeting with them since the final three days of the consultant coincided with holidays.

3. CONCLUSIONS

After visiting various departments in the Shahid Beheshti University, several research institutes and some industries, and having discussions with the president of the university, university staff members, Ministry of Industry officials, private entrepreneurs, and the architects and engineers of the building, the following conclusions were reached:

3.1 Plant Taxonomy

Iran has a rich and diverse flora with about 10.000 flowering plant species and a high percentage of endemics. The climate, soil, land form and geography of the country make it suitable for many medicinal

and aromatic plants of the dry, temperate and sub-tropical zones to grow. Although the publication of the flora of Iran has not been completed yet, it is well known. Collections of dried Iranian plants are kept in well established herbariums in Iran such as the Central Herbarium in RIFR, and abroad. RIFR also maintains a Botanical Garden in Karaj. The Forests and Rangelands Organization and the Department of Environment are charged with the duty of declaring and maintaining national parks and protected areas. There are, at present, seven national parks, four national nature monuments, twenty four wild life refuges and forty two protected areas. These seventy seven protected areas are under the responsibility of the Department of Environment. The Forests and Rangelands Organization maintains Iran's sixty four forest reserves and fifteen national forest parks.

Iran has well trained and experienced plant taxonomists. The Department of Biology at Shahid Beheshti University maintains a herbarium which is cared for by skilled plant taxonomists.

On the plant taxonomy and plant conservation issues, the country has developed awareness, experience, trained manpower and facilities. This is seen as a good sign for the initiation of further work on medicinal and aromatic plant of Iran.

3.2 Agriculture

Several public and private institutions are interested and engaged in the cultivation of medicinal and aromatic plants in Iran. Seeds or planting materials of selected plant species obtained from abroad are being planted in large areas and promising wild plants are being domesticated. Although most crops are used for making products for the local market and some essential oils are exported, systematic, scientific, goal-oriented cultivation practices are hard to come by. In one farm visited, doubts were shed on the identity of some plants. It looked rather like a hobby farming rather than scientific farming. However, it must be pointed out that the culture and tradition of cultivating medicinal and aromatic plants exists in Iran. Even in the vicinity of the Shahid Beheshti University, in the fields of Jahad Daneshgahi, cultivated medicinal and aromatic plant crops sufficient for the operation of the proposed pilot plant of the Medicinal Plant Research Centre are available.

3.3 Phytochemistry

Scientific work has been carried out in the pharmacognosy and chemistry departments of several universities including Shahid Beheshti University by individual scientists on the extraction, isolation, purification and structure elucidation of phytochemicals in Iran. Such work which is carried out in isolation and without coordination and knowledge of other scientists is generally rewarded by the publication of research results in scientific journals.

The Phytochemistry Department of the Shahid Beheshti University has in the past 20 years published 93 papers on the chemical constituents of 63 Iranian plants. Many new compounds were discovered under the able supervision of Prof. Rustaiyan and the results were published in scientific journals. This proves the ability of the department to perform phytochemical studies, and justifies the establishment of the Medicinal Plant Research Centre at Shahid Bheshti University.

In general, research done so far on medicinal and aromatic plants in Iran can only be regarded as pure, basic, sporadic research, and not applied research. It has so far resulted in the discovery of many new phytochemicals without any apparent use, publication of several papers in national and international journals and training of MScs and PhDs. As it is often the case in developing countries the impact of this research on the applied side has been minimal, if not nil.

3.4 Process Technologies

At present, no facility exists in the University for scaling up of bench scale processes developed for medicinal and aromatic plants to pilot plant scale. No pilot plant for extraction, distillation, evaporation and fractional distillation of medicinal and aromatic plant products was seen. Only in the factory of the Pad Shiraz Company in Shiraz, a 200 L distillation pilot plant for essential oils was observed.

Plant extracts and essential oils are produced commercially in Iran by various companies, and the processing plants are fabricated locally. However, in all the factories visited, managers complained about the lack of scientific knowledge, expertise and experience in developing products which are up to acceptable standards. The essential oil manufacturers were puzzled and confused that their oils were not fetching the market prices.

3.5 Biological Activity Studies

These conclusions are based only on observations made at the Shahid Beheshti University. For the last two years, the Pharmacology Department has been engaged in pharmacological research into testing analgesic, antiinflammatory and antiepileptic activities of four plant species, and the Microbiology Department has been working on the antimicrobial activities of a number of plant species. Although the departments are collaborating with the Phytochemistry Department, a systematic plant drug development study has not yet been carried out.

3.6 Building

The building of the centre has a futuristic look. It is to be constructed on a hill overlooking the university campus. According to the information provided, the building will be quite spacious and will contain all necessary facilities and utilities. The layout plans of the pilot plant building, in particular, was examined by the consultant and the architects. The consultant's recommendations are summarized in the next chapter.

3.7 Final Conclusions

Research done on medicinal and aromatic plants of Iran has not so far resulted in the development of new products or medicines. Phytochemistry departments in universities are mainly engaged in research into isolation and identification of chemical constituents from plant materials. This has resulted in the discovery of many phytochemicals and publication of several papers in scientific journals. As it is often the case in developing countries, the impact of these research works on the applied side has not been felt. Bench scale research can only be translated to action by developing process parameters for industrial scale production. A bench scale work cannot be scaled up to commercial production by making a few calculations. An important stage in between should be fulfilled. This is pilot plant scale production to determine process parameters for the production of a particular product. Here, the services of chemical technologists are required. Only after the completion of pilot scale processing studies, a sound basis for designing commercial scale processing plants, and enough amount of products for formulation and market research can be achieved.

The development of a medicinal product from plant materials needs a multidisciplinary approach involving the services and close cooperation of a team of taxonomists, agronomists, phytochemists, analytical chemists, chemical technologists, toxicologists, pharmacologists, formulation specialists, clinicians and market researchers with the help of librarians and information specialists.

Research work performed in university laboratories is generally research-oriented and the objective and the desire of a researcher working there is to solve problems encountered in basic sciences. Even the applied research done in most university laboratories is far from bringing about practical or applied results due to lack of coordination among several disciplines and to the non-availability of facilities to pursue such research.

All these activities can be performed in a well-coordinated and well-managed medicinal plant research centre possessing well-trained, enthusiastic researchers, good library and information facilities and facilities for testing and processing to pursue the required product development studies.

Such a need is strongly felt in Iran. The industry indicated the need of expert help and advice in solving their immediate problems. During a meeting at the Ministry of Industry, the representatives from plant-based industries welcomed and supported the idea of establishing a Medicinal Plant Research Centre in Shahid Beheshti University. The same day, The President of the Islamic Republic of Iran, Mr. H. Rafsanjani 's remarks on urging the scientists to develop medicines based on indigenous medicinal plants of Iran took place in newspapers.

The establishment of the centre is appropriate and timely. It should be equipped and manned to function as a goal-oriented and/or demand-oriented industrial research and development centre geared to solve industrial problems, develop process technologies and analytical testing procedures. Toxicological and microbiological testing and pharmacological studies for new drug development should be pursued on plant based products. The centre should provide training to the industry and serve as an information centre on all aspects of medicinal and aromatic plants including trade information.

4. RECOMMENDATIONS

4.1 The Philosophy of Establishing a Medicinal Plant Research Centre in a Developing Country

A research centre is established to fulfil one or more specific goals. The benefits from establishing a research centre should be envisaged in the beginning and be measurable after a certain period of time. The goal of establishing a medicinal plant research centre in a developing country, basically, is to conduct research into taxonomical, ethnobotanical, phytochemical, phytopharmacological, pharmacognostic aspects of the flora of the country and to develop process technologies for promising plant drugs through the use of pilot plants and eventually make them commercial products, hence pumping the industrial development of the country by creating job opportunities and income generation, contributing to the solution of health problems, bringing in foreign currency through exports, and cutting down imports. In short, the centre should perform applied research to help the country's development and not pure research for the sake of science and training academics. Pure research can be done at universities and the graduate institutes can use the facilities of the centre for training graduates. But the centre should be geared to solving industrial problems using a multidisciplinary approach. Although scientific principles should be observed in the execution of each and every project, a project should produce practical solutions to the problems that the country experiences. In order to keep the scientific quality of the researchers high, they should be encouraged to do MSc and PhD under the supervision of suitable academic staff in a graduate institute. The subjects for thesis work should be related to the research objectives of the centre.

The country may have abundant sources of wild growing medicinal and aromatic plants, however, in order to safeguard the supply of raw materials for the plant-based industries, cultivation of the promising plant species should be encouraged and realized.

Research is an expensive endeavour. It requires well-trained, enthusiastic researchers, good library and adequate laboratory facilities. Money can buy the best equipment and all the books, but it cannot buy good researchers. A good researcher is a person who has been well trained in the discipline and he who is dedicated to his work. He should have self-discipline and a sense of cooperation. He should be liberal in his thinking and be a patient worker. He should not deviate from rationalism and should not be easily carried away by the exciting research results he obtains. He should be critical of his own results and should listen to the judgement of his own conscience. That is, a researcher is born with this qualities and improves them with proper training and guidance. A research centre should strive for finding such researchers and train them according to the research policies and goals of the centre.

A good research centre can only function and be successful by the direction of a director with vision and enthusiasm. His scientific background on the subject as well as his personality is a key to success. He should be a person with good leadership qualities and a just but well disciplined administrator. Young scientists working under him should envy his qualities and respect him. They should not be under the stress of threats, and his loving and caring approach should encourage them to be more productive and fruitful. He should have good supervising qualities and his close interest and guidance should give the researcher a sense of security and constant encouragement. A researcher should be given responsibility at times, so that he gains confidence after the accomplishment of the work. Good work of a researcher should be rewarded but this should not be overplayed to create unnecessary friction and isolation among the group. While rewards should be given publicly, the penalties or warnings should always be made personally.

A good director is a person with enviable public relations qualities. He should be a sociable character easily mixing with people and representing his centre in scientific or social meetings at all levels with success. He should be well respected by every one, not only for his scientific calibre but also for his kind personality, and he should use this advantage to the advancement of the centre.

Naturally such a personality is envied by others and jealousy may sometimes obstruct his way. His determination and will can easily overcome such transitional problems. He should try to win over his rivals rather than create more of them. A director is like a receiver. Even if he does not make an attempt to receive, almost all the secret talks or gossips reach him. He should not encourage such spying. He should wait for at least 24 hours before taking a disciplinary action against his staff members, not immediately after the incident.

He should not let anybody under him to create a monopoly on anything. Therefore, for instance, he can give responsibility of an equipment to a person but train two or three people how to use that equipment. This is a safeguard for the continuity of the service of that particular instrument, as well as an assurance that its service does not depend only on one person.

Team work at the centre should be encouraged and individualistic or selfish attitudes should be discontinued or prevented. Researchers in a research centre are required to work under a certain work discipline and are expected to obey the rules of the house. They should not try to implement research projects without the knowledge and prior consent of the director. They should consider themselves truly as "research workers".

While working on an industrial problem on behalf of an industrial company, secrecy must be observed throughout the work and later. Only the researcher(s) involved in the work should know about it and they should not discuss the results with unrelated researchers or outside the centre. They should only report to the director. The director or a person assigned by him only should liaise with the industry concerned, make necessary contacts, and write interim or final reports. Researchers should not directly report to the industry without the consent of the Director.

4.2 Medicinal Plant Research Centre of SBU

After a thorough study of the existing facilities, staff situation and future plans of the Medicinal Plant Research Centre at the Shahid Beheshti University, the Consultant has come to the conclusion that the University is an ideal venue to establish this Centre and has made the following recommendations for its strengthening. It is recommended to link the centre directly with the University President's office in order to minimize bureaucracy and to get the participation of different faculties and departments of the university to the activities of the centre more readily.

The Medicinal Plants Research Centre of the Shahid Beheshti University should consist of the following departments: (Annex 11).

1. Botany Department
2. Pharmacognosy Department
3. Biological Activity Department
4. Process Technology Department
5. Library and Information Department
6. Agronomy Department
7. Commercial Activities Department

4.2.1 Botany Department

The Botany Department should deal with the collection of wild growing plant species and their identification. The department should keep a Herbarium. The library of the centre should purchase all the books related to the flora of Iran and floras of all the neighbouring countries. Journals publishing articles on the plants of Iran should be received regularly by the library of the centre. Catalogues and check-lists of seed plants, mushrooms, ferns, mosses, likens, etc. should be kept. The Herbarium should have steel cupboards for keeping mounted herbarium specimens and a sufficient number of tables and chairs. Stereo microscopes (3-5 pcs), binocular research microscopes with camera lucida and photographic attachment (2-3 pcs), and dissection sets must be available. Presses, blotting papers, used newspapers and cardboards for making herbarium specimens should be supplied. Glass jars (250, 500 and 1000 ml) for preserving live specimens in alcohol should be kept in stock. Two horizontal deep freezers (-18°C with -30°C shock freezing facility) should be purchased for killing pests in herbarium specimens. The old way of preserving herbarium specimens by poisoning with chemicals has been abandoned in all major herbariums due to serious health hazards that poisoning causes on man. Since humidity is low in Tehran's air, no infestation should be expected in the herbarium specimens preserved by deep freezing for 24-48 hours.

The department should consist of the following units: A) Ethnobotany Unit, B) Herbarium, and C) Ecology and Genetic Improvement Unit.

The department should have at least one 4-wheel drive, long base, field motor vehicle. A portable Global Positioning System (GPS) for determining the coordinates of plant collecting sites, hand altimeters, compasses, sleeping bags and a tent to accommodate three or five people, and a small portable fridge should be kept as standard accessories of the field vehicle. Keeping at least three hand-held wireless communication equipment (Walkie-Talkie) is not only useful in communication during field trips, but can also be life-saving at times. Necessary permission should be obtained from authorities for their nationwide use.

One of the major duties of the department should be to supply necessary plant materials for the phytochemical or biological activity testing work. Therefore, the department should also keep natural-fibre bags of sufficient quantity, serrated field knives, garden shears, small axe, pickaxe, and shovel. Tall carts containing vertical rows of steel trays with chicken-wire mesh bottom should be used for drying plant materials. Such carts should be placed in a well ventilated separate room.

For record keeping, the department should have a computer with access to Internet. It should be used mainly for keeping records of each specimen. A slide and photograph archives should be set up.

It is advisable to move the herbarium of the Faculty of Science of the new building where it can give a better service to the University and the Centre. Presently, ca. 25.000 specimens are kept in a small and stuffy room stacked on top of each other. It is not recommended to establish two herbariums in the same university.

The department should be run by a trained plant taxonomist with ample experience on the flora of Iran. The Centre has five staff members of the Biology Department of the acuity assigned to serve part-time, therefore, at least two full time staff members, preferably, new graduates with degree in botany and at least one technician should be employed.

4.2.2 Pharmacognosy Department

It should be responsible for conducting chemical and analytical studies concerning medicinal and aromatic plant materials and products. The department should consist of the following laboratories: A) Phytochemistry Laboratory, B) Analytical Laboratory, C) Pharmacognosy Laboratory.

A) Phytochemistry Laboratory

The Phytochemistry Laboratory should have facilities for bench-scale extraction, distillation, isolation, filtration, evaporation and drying. The following equipment, apparata and supplies should be obtained:

1. Laboratory glassware and metalware.
2. Consumables such as chemicals, solvents, adsorbents, reagents, etc.
3. Rotary evaporators with vacuum and temperature controllers, and water jet vacuum attachment (if central vacuum facility is not available) complete with temperature controlled water bath, flasks and spares (at least 2 pcs).
4. Glass Soxhlet Extractors (250 ml - 10 sets, 500 ml - 5 sets, 1000 ml - 3 set and 2000 ml - 2 sets).
5. Glass Clevenger type apparatus for essential oil content determination (for lighter than water oils) complete with heating mantles and 2000 L round bottom flasks (5 pcs each for oil-rich and oil-poor materials).
6. Volumetric Moisture Content Determination Apparatus complete with heating mantle (10 pcs).
7. Buchner Filtration set-up (a range of all available sizes).
8. Chromatography columns made of glass or solvent resistant synthetic material.
9. Thin-Layer Chromatography (TLC) plate spreader unit
10. Cut glass TLC plates of sizes 5x20, 10x20, 20x20 and 40x20 cm (50 pcs each).
11. TLC Chromatography Tanks to develop the abovementioned plates.
12. Plate Spraying Cabinet with spray guns
13. TLC Plate Heaters (3 pcs).
14. Hot Plate/Magnetic Stirrers with speed and temperature controls (5 pcs).
15. Drying Ovens with thermostatic control and timer (2 pcs).
16. Heating Mantles with thermostats to suit various sizes of flasks mentioned above (3 pcs each size).
17. Water Baths with thermostatic control, to take up to six flasks at a time with concentric cover rings (3 pcs).
18. Circulating Thermostatic Water Bath
19. Flask shakers (5 pcs)
20. Electronic Balances (Top loading - 2 pcs, analytical - 3 pcs).
21. Mechanical Balance (weighing up to 3 kg).

22. UV Lamps (2 pcs - one hand held and the other mounted in a cabinet).
23. Distilled Water Still (10 L/h capacity).
24. Water Deionizer (300 L/h cap.)
25. Laboratory Centrifuge (10.000 rpm) with tubes and various size changeable rotors to suit most tube sizes.
26. Fridge/freezer
27. Deep Freezer, horizontal type, -18°C, 250-300 L
28. Bench-top Freeze Dryer with manifold and chamber with tray-heating and vial stopper attachments.
29. Bench-top Spray Dryer
30. Vacuum Oven complete with controls
31. Chromatotron, centrifugal thin-layer chromatography system with pump and other accessories and supplies.

The laboratory should be maintained and run by trained phytochemists with a degree in chemistry or pharmacy. At least two young graduates with BSc degrees in chemistry or pharmacy, and at least one technician should form the core full-time staff of the Unit.

B) Analytical Laboratory

The main function of this laboratory will be to give service to the other units and departments needing its services. All chromatographic and spectroscopic instruments and equipment for physicochemical determinations and assays will be kept in this laboratory. Ideally the laboratory should have the following instruments:

1. Electronic Polarimeter
2. Abbe-type Refractometer
3. UV/VIS Spectrophotometer
4. Infrared (IR) Spectrophotometer
5. Gas Chromatograph (GC)
6. High Pressure Liquid Chromatograph (HPLC)
7. Medium Pressure Liquid Chromatograph (MPLC)
8. Gas Chromatography/Mass Spectrometry (GC/MS) System
9. FT-NMR Spectroscopy System
10. Polarograph
11. Atomic Absorption Spectrophotometer
12. TLC-Scanner (Densitometer)
13. FT-IR Spectrophotometer
14. Electronic Analytical Balances (2 pcs)
15. Fridge/Deep-Freezer
16. pH-Meter/Conductimeter
17. Ultrasonic Bath
18. IR Presses for making KBr discs

Some of the sophisticated equipment kept in the Central Instrumentation Facility and are functional such as GC/MS (Shimadzu QP1100), FT-NMR (80 MHz, Varian), Atomic Absorption Spectrophotometer, Polarograph, etc. should be moved to the MPRC building, however, it will be necessary to purchase modern versions of UV/VIS and FT-IR spectrophotometers, GC, HPLC, MPLC, TLC-scanner, etc. This is true even if all the other instruments in the Central Instrumentation Facility are to be moved to the new building.

The laboratory should be under the responsibility of an analytical or physical chemist. At least three full-time staff should be responsible for maintenance and operation of the instruments. A skilled technician is also required.

C) Pharmacognosy Laboratory:

This laboratory will be responsible for the identification, authentication and quality control of powdered or whole plant drug materials, and will prepare monographs and specifications for the standardized plant drugs. The laboratory will also carry out pharmacopoeial analyses. The laboratory should be equipped with binocular research microscopes with camera lucida attachment, stereomicroscope, muffle furnace for ash content determination, moisture balance, top-loading and analytical balances (one each), and other laboratoryware. The unit will use the facilities of other laboratories if necessary.

A trained pharmacognosist should be responsible for activities of this laboratory. One young enthusiastic pharmacist should be employed as an assistant.

4.2.3 Biological Activity Department

The overall objective of this department will be to conduct biological activity screening tests for plant extracts, essential oils, or their fractions and isolates. The department should cooperate with the Phytochemistry Laboratory in bioassay guided fractionation studies.

The department should consist of the following laboratories: A) Pharmacology Laboratory, B) Animal House, and C) Microbiology Laboratory

A) The Pharmacology Laboratory:

This laboratory should carry out acute, subacute and chronic toxicity assessment and Hippocratic screening tests, and other in-depth pharmacological studies using intact animals and isolated organs. Therefore, it should be equipped with basic equipment for Hippocratic screening, dissection sets, isolated organ baths, multichannel recorders, etc. It is advisable for the laboratory to establish an animal tissue culture facility containing a laminar flow cabinet, CO2 incubator, refrigerated centrifuge, fluorescence and invert microscopes, gamma-counter (RIA), ultra deep-freezer (-85°C), cold room (+5/-5°C) and liquid nitrogen tanks.

The establishment of an animal tissue culture laboratory should only be considered if trained staff on animal tissue culture techniques is available.

A trained pharmacologist should be responsible for the management of the Pharmacology Laboratory. At least, two research assistants and one skilled technician should be employed as full-time staff.

B) Animal House:

The Animal House should be considered an integral part of the Pharmacology Laboratory. It should have necessary amount of cages, stacked carts for cages, operation tables, dissection sets, etc. Since there are animal house facilities at the Biology Department and the Faculty of Medicine, this facility should be maintained for the ready supply of animals for the activities of the laboratory. Therefore, it should be managed by a technician and a worker.

C) Microbiology Laboratory:

This laboratory should deal with the assessment of antibacterial, antifungal activities of plan drugs using microorganisms. The laboratory should also test microbial and fungal contamination in plant drugs. The laboratory should consist of the following basic equipment: research microscopes, autoclaves, incubators, laminar flow cabinets, sterilizing ovens, water baths, colony counters, ultracentrifuge, bench-top centrifuges, other laboratory glassware and metalware.

The laboratory should be managed by a trained microbiologist. At least two full-time research assistants and two skilled technicians should be employed.

The establishment of a Biotechnology Department may be considered as a second phase activity.

4.2.4 Process Technology Department

This department will be responsible for scaling up of bench scale processes to commercial scale through a pilot plant stage. The department will also conduct formulation studies for plant based pharmaceutical and cosmetic products. The department should consist of the following units: A) Pilot Plant Unit, B) Formulation Unit.

A) Pilot Plant Unit:

The Pilot Plant Unit should have a multipurpose pilot plant (500 L cap.), multistage liquid-liquid extractor (100 L/h cap.), glass lined reactor (100 L cap.), all-glass fractionating column (1 L), climbing film evaporator (10 L/h), steam boiler (oil or gas fired, 500 kg/h steam, complete with water softening unit), platform balance (200 kg), basket centrifuge (S/S, basket dia. 450 mm, vapour-tight design, explosion proof motor), filter press (S/S, 600x600 mm, 10 plates/frames, vapour tight with ex-proof motor/starter), hammer mill (50 kg/h), cabinet dryer (50-100 kg/batch), Buchner type vacuum filter (120 L), Spray dryer (20 kg/h water evaporation capacity), storage tanks (S/S, 150 L , 3 pcs), Aluminium containers (20 and 50 L, 6 pcs each), PVC tanks (20 L, 10 pcs) all with tight fitting top covers.

The pilot plant unit should be operated by two chemical engineers, two assistant engineers, one technician and two workers.

It is understood that the building will have a general workshop for repair, maintenance and fabrication of small equipment. For the process technology development activities of the centre the workshop should have the following equipment:

1. Turning lathe with chuck 5 ft bed complete with all accessories, tools, essential spares.
2. Pedestal drilling machine cap. up to 25 mm dia. holes, with tools, accessories and spares.
3. Portable drilling machine with tools accessories and spares.
4. Portable cutting/grinding unit with tools, accessories and spares.
5. Argon arc welding set with tools, filling rods, accessories and spares.
6. Electric arc welding set, 200 Amps electrodes, complete with tools accessories and spares.
7. Oxy-acetylene cutting/welding set with accessories and spares.
8. Motorized hacksaw machine with tools, accessories and spares.
9. Hydrolic pipe bender, manually operated with tools, accessories and spares.
10. Working tools: sets of spanners, pipe wrenchers, hammers, etc.
11. Stainless steel pipes, valves, sheets, etc.
12. Mild steel seamless pipes, fittings and valves.
13. G.I. pipes, fittings and valves.

However, a modest facility comprising working tools (see no.10 above) can be set up in the pilot plant building for simple repairs and maintenance, installation and dismantling of pumps, motors, etc.

B) Formulation Unit:

The Formulation Unit may be considered as a second-phase activity. The first phase development should concentrate on the production of standardized extracts and essential oils, and their fractions or isolates.

This unit should be managed by a pharmaceutical technologist with experience in formulating pharmaceutical and cosmetic products. In addition, one pharmacist assistant and one technician are sufficient for initial work.

4.2.5 Library and Information Department

This department will play and extremely important role in the activities of the centre since a literature survey on all the projects will be necessary before implementation. Therefore, the library of the Centre should be recognized by the University as a reference library and all the related books and journals presently kept in the main library or the departmental libraries should be transferred to the centre's library. An archives of reprints should be set up. Key-worded data on all the books, theses, reports, reprints and articles related to plants in journals kept in the library should be entered in a database for easy and quick retrieval of data by the Information Unit. An indicative list of books and journals seen necessary for the library is annexed. The department should consist of the following units: A) Library and Documentation Unit, B) Information and Data Processing Unit, C) Publication Unit

A) Library and Documentation Unit:

The functions of this unit is explained above. Book letting should not be allowed in the unit and the library should keep a reference library status. An archives of reprints, articles, reports, brochures, etc. as well as videos, films, photographs and slides should be established. The unit should have at least two personal computers as part of LAN, slide projector, overhead projector, video recorder/player and a TV monitor.The library should be managed by an experienced librarian and two librarians should give assistance. A list of books and journals recommended for the library are annexed (Annexes 12 and 13).

B) Information and Data Processing Unit:

This unit should establish on-line and off-line linkages with databanks such as DIALOG, STN, DATASTAR, and information networks such as Internet. Databases should be created for library holdings and for the medicinal and aromatic plants of Iran. For linkages with local area networks (LAN) and internet, mainframe computer facilities of the University can be used via fibre optic cabling. However, for on-line linkages with commercial databanks direct telecommunication facilities should be established at the centre through PTT services of the country. The unit should also process and provide information on market trends and world prices of plant based commodities.

Access to Napralert (Natural Products Alert) database of the University of Illinois at Chicago through Bitnet or Internet can be negotiated.

For the creation of databases, suitable softwares can be ordered from private software houses. Therefore, the centre does not need to employ a software specialist permanently. However, it is pertinent to employ a computer (and/or information) specialist for data processing, data entry and retrieval of data. A group of undergraduate students can be hired to do data processing and data entry in their spare time under the supervision of information specialist with the help of subject specialists who can be called from various departments of the centre. A local area network (LAN) should be established in the centre (possibly via fibre optic cables) by linking all the computers. Each computer should be able to reach the databases created and be able to enter data. It is advisable to enter all data into databases in English for the centre to have international recognition.

The unit should be equipped with computers, server, printers, modems, scanner, mass data storage facilities.

C) Publication Unit:

This unit should produce brochures, leaflets, newsletters, bulletins an a scientific journal as part of promotional activities of the centre. The unit should also be charged with the duty of preparing photographic and overhead slides and posters of the centre for presentation in symposia or for other educational purposes. The unit should liaise with the press and perform other public relations functions such as organization of symposia, etc. The unit should have computer, colour scanner, colour printer, laser printer, video projection, slide and overhead projection facilities. The unit should be run by a publishing expert together with a public relations person. One assistant each is suitable for the initiation of activities.

4.2.6 Agronomy Department

An agronomist should be responsible for the activities of the centre related to agriculture. He is expected to organize the domestication (wild or introduced species) and cultivation of several selected medicinal and aromatic plants jointly with agricultural institutions such as Jahad Daneshgahi and/or Jahad Sazandegi, in their fields. Cultivated crops will be needed for pilot plant operations. Jahad Daneshgahi has an office in the SBU campus. A list of medicinal and aromatic plant species cultivated by Jahad Daneshgahi is annexed (Annexes 14 and 15). The quantities harvested seem enough for the operation of the pilot plant. The department may consider cultivation in its own fields during the second phase of development if the need to do so is felt strongly. A priority list of plants for study at the centre is proposed (Annex 16).

4.2.7 Commercial Activities Department

Commercialization of research results would greatly depend on close liaison with the industry and the centre should be able to demonstrate to the industry the facilities and research capabilities to solve their possible problems. They should be encouraged to seek centre's support to develop joint research projects. As soon as the centre establishes its research and development facilities and capabilities and is ready to serve the industry, good laboratory practice should be fully in force, so that permanent and reliable records of each work can be kept.

The centre is expected to sell its services to the industry to earn part of its money. Such commercial operations can start only after the centre establishes its facilities and proves its capabilities as explained above. Then, a marketing specialist should be employed to start activities at this department. He should act as an adviser to the Director of the centre in planning for commercial activities such as marketing of services like analytical testing of oils and extracts, pilot plant processing of medicinal and aromatic plants, training of technical staff from the industry, preparation of contracts and work protocols with commercial companies. He should also do the book keeping of the centre for such activities.

A suitable mechanism should be created in the university to enable to use the income generated through its services to meet its own needs. It can be in the form of a revolving fund. This extra-budgetary fund should have the flexibility of depositing a certain portion of its holdings in foreign currency, so that any maintenance and spare part requirements can be readily met. A certain percentage of this fund can be distributed to the researchers for encouragement.

4.2.8 Building

Advice was given to the architects and engineers of the building contracting company about modifications on the layout plans mainly concerning the pilot plant building (Annex 17).

In short, the following recommendations were made:

The ground floor of the pilot plant building should have utilities and service departments for pilot plant operations. All the areas should be well ventilated. Since windows are only required for light in the pilot plant area and storage rooms, they should be placed high up to provide space on the walls to set up equipment, and to line electrical cables, steam, air and water pipes. The windows should face north/south to avoid direct light into the pilot plant area. The electricity at the pilot plant area must be both monophase and triphase, and must be fully ex-proof. An emergency shower should be provided in the pilot plant area. 9 meters height, the width and the dimensions of the pilot plant area were found sufficient. Some cubicles should be provided on one (narrow) side of the area for engineers' and technicians' use. The top of these cubicles could be used as a platform to set up equipment not requiring tall ceiling. A two-way crane should be installed on the ceiling suitable to lift upto 1 ton. A steam boiler (oil-fired or gas-fired) to yield 500 kg steam per hour should be installed separately in the boiler room. Chilled deionized or softened water should be circulated in condensers. The ceiling of the pilot plant area should easily fly off in case of explosion in order not to damage the whole building.

A change room, toilet(s), and a shower facility should be provided outside the pilot plant area possibly opening to the corridor leading to the pilot plant. A small workshop facility should be made available for maintenance and small repairs.

The plant material storage area should have a separate tray-drying room for drying wet or semi-humid plant materials. The plant storage should have direct access to the pilot plant area through a corridor with access to a separate well-ventilated grinding room. Finished products can be stored in another room opening to this corridor. In the pilot plant building adjacent to the plant storage, there is enough space to create a second pilot plant area for short equipment and processing plants.

A spray drying room will be necessary to house a pilot-plant scale spray dryer. A dry space should be provided for the storage of supplies, spare parts, pumps, motors, and accessories of pilot plant equipment.

Fire fighting facilities must be available in all areas.

It is recommended for a civil engineer and/or architect, one each from the university and the contractor company to visit similar centres abroad (e.g. TBAM in Turkey, Archimex in France) during the early stages of the construction and certainly before the completion of the building.

4.3 Activities of the Centre

An exemplary list of activities which may be carried out by the Medicinal Plant Research Centre is as follows:

1. To make an inventory of wild growing and cultivated medicinal and aromatic plants of Iran.
2. To determine localities, soil, water and climatic requirements and availability, etc. of the abovementioned plants.
3. To initiate a database containing the above as well as ethnobotanical data collected from people.
4. To keep an archives of research work done on Iranian plants containing reprints or photocopies of articles, theses, reports which appeared in national and international journals.
5. To carry out phytochemical, pharmacological, microbiological screening of the medicinal plant flora of the country.
6. To realize systematic screening of aromatic plants of Iran to discover potential new sources of essential oils and aroma chemicals.

7. To conduct multidisciplinary research into developing commercial products from a selected number of medicinal and/or aromatic plants available in Iran in sufficient amounts to sustain and support and industry. Processes and products developed by the centre should be demonstrated to the industry to attract their attention for possible industrial production.
8. To train young full-time staff of the centre through in-house training, and fellowships in and out of Iran. On-the-job training can be given by local or foreign experts.
9. To liaise closely with the industry to encourage them to come to the centre for solving their analytical, technological and marketing problems.
10. To liaise with the other research institutions and related government departments in drawing up specifications for standardized plant products.
11. The centre should organize workshops, training programmes, seminars and publish newsletters, bulletins, brochures, scientific reports, and journal to promote its image, prestige and recognition.
12. The centre should follow the code of Good Agricultural Practice, Good Laboratory Practice, Good Manufacturing Practice and Good Clinical Practice as much as possible in order to ensure Total Quality Management.

4.4 Proposed Strategy for the Strengthening of the Centre and UNIDO's Involvement

The development of the centre should be realized in two phases.

During the Phase I, Botany, Pharmacognosy, Biological Activity, Process Technology and Library and Information Departments should be strengthened. Collaborative research should bring about the development of pharmaceutical and cosmetic raw materials in the form of standardized extracts and essential oils.

In the Phase II, the strengthening of Agronomy, Commercial Activities Departments, and Biotechnology, Tissue Culture and Formulation Sections should take place.

The proposed strategy for the Phase I is as follows:

1. Based on the findings and recommendations stated in this report, a project should be developed. The project document should clearly state the objectives, outputs, activities, and inputs. The Phase I project should be for a duration of three years.

2. Since the construction of the building will take at least two years to complete, the project activities should start before its completion. During this period some bench scale processes and quality control procedures can be developed. Cultivation of selected plant species can be organized jointly with agricultural institutions. Training of the young full-time staff can be realized by local and foreign experts, or through fellowships abroad. Pilot plant engineers can take tailor-made courses abroad wherever a multipurpose pilot plant is functional on the uses of this plant.

3. UNIDO's involvement in both the preparation and execution of the project is strongly recommended due to the following reasons:

a) Among all the UN agencies UNIDO is the only one with a clear mandate for industrial development and the only one having vast experience and expertise on the industrial utilization of medicinal and aromatic plants. Numerous UNDP-funded projects have been and are being successfully executed in many developing countries of Asia, Africa and Latin America.

b) UNIDO's skill and experience in executing medicinal and aromatic plant projects has not only resulted in the establishment of successful research centres in several countries but also helped in the creation of a comprehensive roster of experts and training institutions in almost every field of applied research.

c) UNIDO is capable of hiring the best experts and consultants to work in developing countries, and to provide training opportunities for project personnel to get the required training in the best possible factories and the centres of excellence.

d) UNIDO's scrupulous follow-up and evaluation procedures make remedial action to be taken in time for timely and orderly execution of the project.

e) UNIDO can purchase project equipment with guaranties from the manufacturing companies. No company wants to take the risk to be black-listed by UNIDO for supplying phoney or used equipment.

It is appropriate to plan for the Phase II activities towards the end of Phase I. The tentative budget and proposed list of equipment are given in Annexes 18 and 19 respectively.

ANNEX 1

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Project of the Government of Iran

JOB DESCRIPTION
UC/IRA/95/161/11-51/0730OO

Post title: Consultant in R & D, Processing and Quality Assessment of medicinal and aromatic plants

Duration: 0.7 m/m

Date required: April 1996

Duty station: Teheran, Iran

Purpose of mission: To provide advice on the establishment of a Research and Development, Training and Information centre for processing of medicinal and aromatic plants

Duties: The Consultant is expected to perform the following duties in collaboration with the staff of the Department of Chemistry of the Shahid Beheshti University and the Director-designate of the proposed centre:

- Assess the current state of research and development,industrial production, quality assessment and validation of the products for use as medicines.
- Study the publications on the flora of Iran and recommend a priority list of plants that could have the potential for industrial utilization.
- Assess the availability of these plants and recommend those that need to be systematically cultivated and those that require agrotechnology development.
- Examine the building plans and recommend the requirements in terms of services, layout of laboratories, equipments that would be needed for the proper functioning of the different units of the proposed centre.
- Assess the training needs of the Faculty to make the centre fully operational.
- Deliver a series of lectures outlining the different activities that should be undertaken by the centre with special reference to R & D, quality assessment and product development.

- Recommend the requirements for the development of the centre into one that will serve the Industry based on medicinal and aromatic plants with respect to training, quality control, information dissemination, certification, problem solving and product development.

Prepare a comprehensive report containing the findings and recommendations to be presented to the officials of the University and the Government and UNIDO.

Qualifications: Chemist/Pharmacist/Technologist with postgraduate qualifications and over 10 years experience in R & D, processing, quality assessment, product development and planning activities relating to industrial utilization of medicinal and aromatic plants.

Language: English

ANNEX 2

WORK PROGRAMME OF THE CONSULTANT AS SCHEDULED BY HOST AUTHORITIES

16 JULY TUESDAY

Arrival in Iran

Visit to UNDP with the Chairman of Medicinal Plant Research Centre

17 JULY WEDNESDAY

Introduction to project executives

18 JULY THURSDAY

Tour of Tehran

19 JULY FRIDAY

Holiday

A Botanical excursion to Elbruz mountain as requested by the consultant.

20 JULY SATURDAY

Work session with the Phytochemistry Research Group

21 JULY SUNDAY

Visit to the office at the Ministry of Industry dealing with UNIDO.

Work session with the Microbiology and Pharmacology Group

22 JULY MONDAY

Work session with the Agronomy/Botany Research Group

23 JULY TUESDAY

A lecture on TBAM and its research activities

Work session with the Pilot Plant Research Group

24 JULY WEDNESDAY

Meeting with the President of the University and the Building Development Group

25 JULY THURSDAY

Tour of the Botanic Garden of Jahad Sazandegi in Karaj

26 JULY FRIDAY

Holiday. Day-trip to Shiraz to visit Pad Shiraz Company

Lecture on Turkish Rose Oil at Shiraz University Faculty of Science

27 JULY SATURDAY

Tour to Kandelous Facilities in Kandelous near Chalus

28 JULY SUNDAY

Free day

29 JULY MONDAY

Visit to the Golkaran Agro Ind. and Golchekan Agro Ind. in Kashan

30 JULY TUESDAY

Work session with project executives

Work session with building contractors

31 JULY WEDNESDAY

Meeting at the Ministry of Industry

1 AUGUST THURSDAY

Holiday

2 AUGUST FRIDAY

Holiday

3 AUGUST SATURDAY

Holiday

4 AUGUST SUNDAY

Departure from Iran

ANNEX 3

PEOPLE CONTACTED

Ministry of Industry

Mr. Ahmad Ahmadi, Head, UNIDO Coordination Office

Mr. M.R.Ha'iri-Yazdi, General Director of Research

Mr. A.R.Nazar Ahari, Project Manager, UNIDO Coordination Office

Mr. Habib Golmaryami, UNIDO Coordination Office

Mr. A.Hosseinzadeh, UNIDO Coordination Office

Ms. Farahnaz Tafik, Expert, Engineering Services

Ms. Zahra Yari, Expert

Ministry of Foreign Affairs

Mr. Majid Hamedani

UNDP

Dr. H.R.Ghaffarzadeh, Programme Officer

Dr. M.R.Bajalan, UNIDO Programme Officer

Dr. Ahmad Malayeri, UNIDO Project Manager, Metalurgical and Engineering Branch, Vienna, Austria

Dr. K.T.D. De Silva, UNIDO Special Technical Adviser, Chemical Industries Branch, Vienna, Austria

Shahid Beheshti University

Dr. Nadimi, President

Dr. Naser Safari, Dean, Faculty of Science; Director Medicinal Plant Research Centre

Dr. Ahmad Shaabani, Chairman, Medicinal Plant Research Centre (MPRC)

Prof. Dr. A. Rustaiyan, Consultant, Medicinal Plant Research Centre (MPRC)

Dr. (Ms.) Zohreh Habibi, Phytochemistry Laboratory, MPRC

Dr. (Ms.) Minoo Dabiri, Phytochemistry Laboratory, MPRC

Dr. (Ms.) Mah Manzar Saberi, Phytochemistry Laboratory, MPRC

Ms. Tayebeh Biniyaz, Phytochemistry Laboratory, MPRC

Ms. Mahnaz Nasiri Aghdam, Phytochemistry Laboratory, MPRC

Ms. Z. Kandi, Phytochemistry Laboratory, MPRC

Dr. Rezvaneh Maleki-Moghadam, Process Technology Department, MPRC

Mr. Saddek Tarverdi, Process Technology Department, MPRC

Ms. Naheed Mashkouri, Process Technology Department, MPRC

Dr. (Ms.) Fereshteh Eftekhar, Microbiology Section, Biology Department, Fac.Science

Dr. Hossein Riahi, Microbiology Section, Biology Department, Faculty of Science

Ms. Farideh Shimi, Microbiology Section, Biology Department, Faculty of Science

Ms. Fatemeh Nourani, Microbiology Section, Biology Department, Faculty of Science

Dr. Abdolhassan Ahmadiani, Pharmacology Department, Faculty of Medical Sciences

Dr. (Ms.) Dina Azizian, Botany Section, Biology Department, Faculty of Science

Dr. Masood Sheidaii, Botany Section, Biology Department, Faculty of Science

Dr. Hossein Shaker, Botany Section, Biology Department, Faculty of Science

Mr. Bahram Zehzad, Botany Section, Biology Department, Faculty of Science

Mr. Zahidi, Head, Chemistry Department, Faculty of Science

Dr. Mohammad Khajavi, Chemistry Department, Faculty of Science

Dr. A. Bageri, Chemistry Department, Faculty of Science; Head, Central Instrumentation Facility

Mr. Saeed H.Davarani, Laboratory Manager, Central Instrumentation Facility

Mr. M.R. Nabbit, Central Instrumentation Facility

Ms. H. Ibrahimzadeh, Central Instrumentation Facility

Ms. Nafise Chaparia, Head, Journals, Main Library

Ms. Menije Kianvash, Head, Book Letting, Main Library

Ms.Marzieh Matin, Civil Engineer, Project Leader, Construction Office

Mr. Saeed Gharari, Civil Engineer, Construction Office

Maher and Assoc. Co.

Mr. H. Koshafar, Head

Ms. Shohreh Zojaji, Architect

Ms. Lida Almasian, Architect

Mr. N. Moghadam, Civil Engineer

Mr. M.A. Abrahimi, Mechanical Engineer

RIFR, Karaj

Dr. A. Jalili, Deputy Director

Mr. Parviz Babakhanlou, Medicinal Plant Department

Ms. Ziba Jamjad, Head, Botany Department

Dr. Valiullah Mozafferian, Taxonomist

Jahad Daneshgahi

Mr. Parviz Ahmadi Avval

Golkaran Agro Ind.Co., Kashan

Mr. Hossein Hejazi, Managing Director, Barij Essence

Mr. Hossein Asgari, Managing Director, Taghtiran

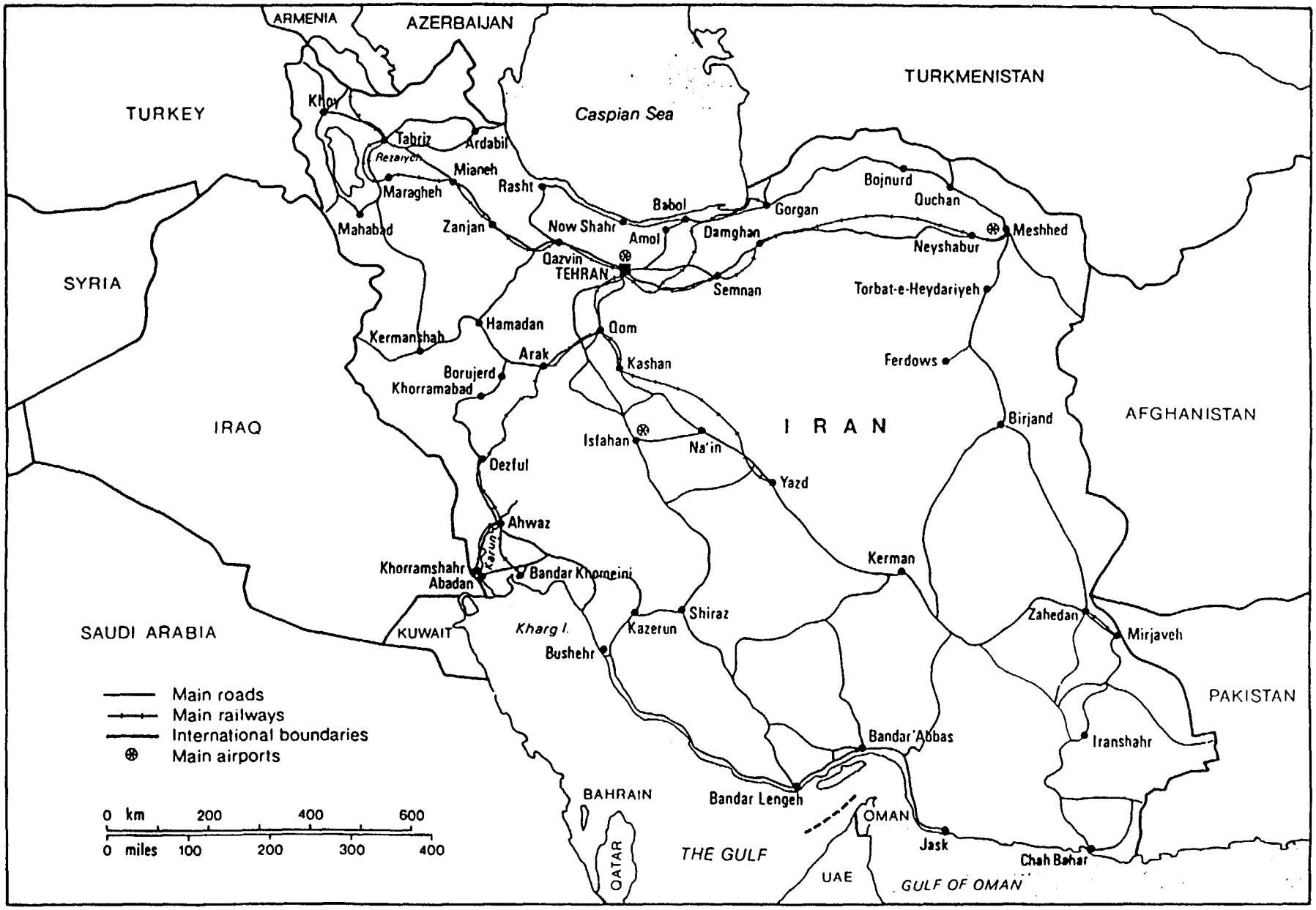
Golchekan Agro Ind.Co., Kashan

Mr. Zia Sadat Tehrani

Mr. Baha Sadat Tehrani

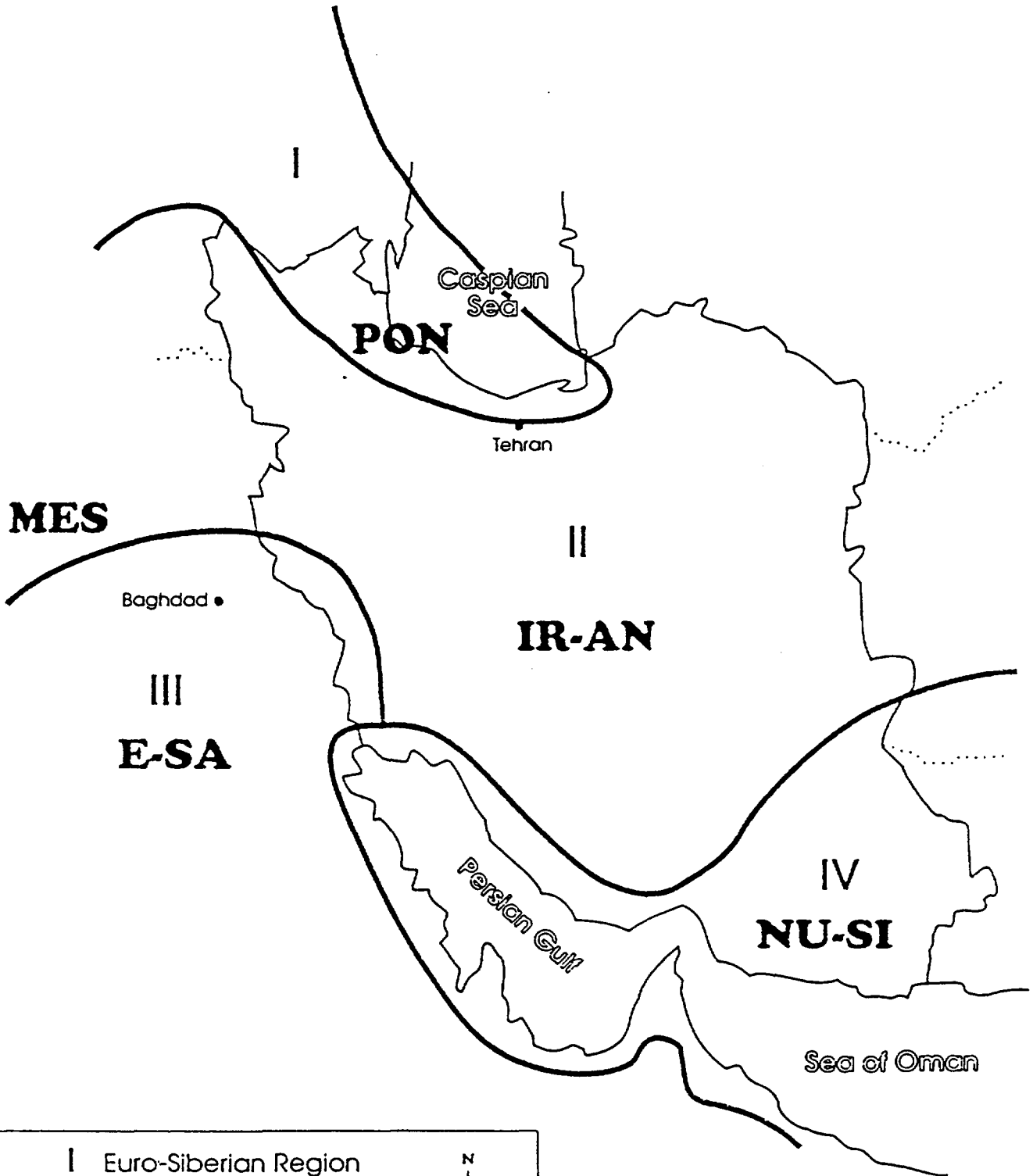
Mr. Mohammad Atabakkhshi

Iran


ARMENIA
AZERBAIJAN
TURKMENISTAN
TURKEY
Khoy
Caspian Sea
Tabriz
Ardabil
Rezaiyeh
Mianeh
Maragheh
Rasht
Bojnurd
Quchan
Babol
Gorgan
Mahabad
Zanjan
Now Shahr
Amol
Damghan
Meshhed
Neyshabur
SYRIA
Qazvin
TEHRAN
Semnan
Torbat-e-Heydariyeh
Hamadan
Qom
Kermanshah
Arak
Kashan
Ferdows
Borujerd
Khorramabad
IRAQ
I R A N
Birjand
AFGHANISTAN
Isfahan
Na'in
Dezful
Yazd
Ahwaz
Karun R.
Kerman
Khorramshahr
Abadan
Bandar Khomeini
Zahedan
Shiraz
Mirjaveh
SAUDI ARABIA
KUWAIT
Kharg I.
Kazerun
Bushehr
PAKISTAN
Bandar'Abbas
Iranshahr
Main roads
Main railways
International boundaries
Main airports
BAHRAIN
Bandar Lengeh
OMAN
0 km 200 400 600
0 miles 100 200 300 400
QATAR
THE GULF
Jask
Chah Bahar
UAE
GULF OF OMAN

MAP 2

Phytogeographical Regions in Iran



I	Euro-Siberian Region
II	Irano-Turanian Region
III	Saharo-Arabian Region
IV	Sudanian Region
PON	Pontic Province
MES	Mesopotamian Province
IR-AN	Irano-Anatolian Province
E-SA	East Saharo-Arabian Subregion
NU-SI	Nubo-Sindian Province

N W E S

ANNEX 6

BOOKS ON THE FLORA OF IRAN

1. Flora Iranica. Flora des Iranischen Hochlandes und der Umrahmenden Gebirge, K.H.Rechinger, Akademische Druck u. Verlagsanstalt, Graz, Austria. 172 fascicles have been published. Not completed yet.

2. Flore de l'Iran, Ahmad Parsa, Imprimerie Mazaheri, Tehran. 5 volumes (1948-1949) and 5 supplements (1952-1974) were published.

3. Flora of Iran, Ahmad Parsa and Zeinolabedin Maleki, Tehran. Only two volumes were published in 1975 and 1986.

4. Flore de l'Iran, A.Ghahreman, Ministry of Environment, Tehran. 16 volumes have been published since 1978. This series is expected to be completed in 80 volumes. Colour photos of Iranian plants are illustrated with botanical information in French. The plants selected are in no particular order.

5. The Plants of Iran, S. Mobayyen, University of Tehran Publication, Tehran. 3 volumes published in 1973, 1978 and 1983. This book is in Farsi.

6. Flora of Iran, Ed.by M.Assadi, M.Khatamsaz, A.A.R.Maassoumi, V.Mozaffarian, The Ministry of Agriculture and Natural Resources, Tehran. Each volume covers one family and is edited by a botanist. So far, 19 volumes have been published since 1988. It is illustrated with line drawings and description of each plant is given in Farsi. This is an ongoing publication.

7. List of Plants of IRAN Herbarium, M.Delghandi, Department of Botany, Ministry of Agriculture, Plant Pest and Diseases Research Institute, Tehran. 20 volumes have been published by end-1991 and is continuing. It lists plants with localities kept in the Evin Herbarium (Acronym IRAN) in Tehran.

8. Tulips and Irises of Iran and Their Relatives, Per Weldelbo, Botanical Institute of Iran, Tehran (1977). This book contains colour photos.

9. Forests, Trees and Shrubs of Iran, H.Sabeti, Ministry of Agriculture and Natural Resources, Tehran, 1976.

10. The Family of Umbelliferae, V. Mozaffarian, Ministry of Agriculture and Natural Resources, Tehran (1989).

11. Astragalus, A.A. Maassoumi, Ministry of Agriculture and Natural Resources, Tehran. 3 volumes published. Vol.1 (1986), vol.2 (1989), vol.3 (1995). These books are in Farsi.

12. Atlas of Astragalus, A.A.Maassoumi, Ministry of Agriculture and Ntural Resources, Tehran.

13. Beliefs and Popular Knowledge in Lorestan and Iran, M.A. Khoramabadi, M.H.B.Farrokhi, M.Kiai, The Iranian Centre of Anthropology, Tehran (1979). This book is in Farsi. It contains Farsi names of plants and their uses.

ANNEX 7

List of Chemistry Journals Kept in the Main Library of the University

(Right-hand side column indicates the years)

1.	Accounts of Chemical Research	1992-
2.	Analytical Chemistry Acta	1992-94
3.	Analytical Chemistry	1983-
4.	Angewante Chemie	1983-
5.	Applied Catalysis A:General, B:Environmental	1994-
6.	Biochemistry	1983-
7.	Bulletin of the Chemical Society of Japan	1986-94
8.	Canadian Journal of Chemistry	1994-
9.	Catalysis Review	1994-
10.	Catalysis Today	1995-
11.	Chemical Abstracts (with indexes)	1907-
12.	Chemical Education	1992-
13.	Chemical Reviews	1983-
14.	Chemical Society Reviews	1985-
15.	Chemistry of Natural Compounds (Transl. of Khim.Prir.Soedin.)	1982-
16.	Chemometrics and Intelligent Laboratory Systems	1992-
17.	Entropie	1994-
18.	Fresenius Journal of Analytical Chemistry	1991-
19.	Inorganic Chemistry	1996-
20.	Journal of Catalysis	1995-
21.	Journal of Chemical and Engineering Data	1985-94
22.	Journal of Chemical Education	1992-
23.	Journal of Chemical Research	1986-
24.	Journal of Ethnopharmacology	1993-
25.	Journal of Micronutrient Analysis	
26.	Journal of Organic Chemistry	1983-
27.	Journal of Organometallic Chemistry	1990-
28.	Journal of Polymer Science	1993-
29.	Journal of the American Chemical Society	1983-
30.	JACS - Chemical Communications	1992-93
31.	JACS - Dalton Transactions	1983-94

32.	JACS - Faraday Transactions (I)	1991-94
33.	JACS - Faraday Transactions (II)	1991-94
34.	JACS - Faraday - Perkin (I)	1991-93
35.	JACS - Faraday - Perkin (II)	1991-93
36.	Natural Products Reports	1992-
37.	Physical Chemistry	1994-
38.	Physical Organic Chemistry	
39.	Phytochemical Analyis	1992-
40.	Phytochemistry	1983-
41.	Planta Medica	1983-
42.	Pure and Applied Chemistry	1983-
43.	Russian Chemical Review	1986-
44.	Synthesis	1992-
45.	Tetrahedron	1983-93
46.	Tetrahedron Letters	1983-

ANNEX 8

List of Biology Journals in the Main Library of the University

1. American Journal of Physiology
2. Annals of Applied Biology
3. Annals of Human Biology
4. Arab Gulf Journal of Scientific Research
5. *Biological Abstracts*
6. Biometrika
7. Botanica Marina
8. Botanical Journal of the Linnean Society
9. Botanical Review
10. Chromosoma
11. Compositae Newsletter
12. Current Opinion in Cell Biology
13. Cymbium
14. Cytologia
15. Ecological Abstracts
16. Ecology
17. Fieldiana: Zoology
18. Flora
19. Genetics
20. Genome
21. Heredity
22. International Review of Cytolog.Supp.
23. Japanese Journal of Ichtiology
24. Journal of Animal Ecology
25. Journal of Applied Ecology
26. Journal of Bacteriology
27. Journal of Cell Biology
28. Journal of Conchology

ANNEX 9

A List of Plants whose Chemistry has been Studies at the Phytochemistry Department and Published in Scientific Journals

Acanthophyllum squarrosum
Achillea eriophora
Achillea micrantha
Acroptilon repens
Aegopordon berarioides
Alepidea amatynsia
Anvillea garcini
Artemisia aucheri
Artemisia diffusa
Artemisia gypsacea
Artemisia haussknechtii
Artemisia oliveriana
Artemisia santolina
Artemisia sieberi
Artemisia spicigera
Artemisia verlotiorum
Ballota aucheri
Calendula persica
Carthamus oxyacantha
Carthamus turkistanicus
Centaurea behen
Centaurea brugueriana
Centaurea calcitrapa
Centaurea imperialis
Centaurea kandavanensis
Centaurea pabotii
Centaurea persica
Cousinia adenostica
Cousinia canescens
Cousinia onopordioides
Cousinia picheriana
Cousinia piptocephala
Dorema aucheri
Elephantopus tomentosus
Erlangea cordifolia
Erlangea fusca
Euphorbia petiolata
Jurinea cardiformis
Jurinea eriobasis
Jurinea leptoloba
Jurinella moschus
Ligularia persica
Mentha mozaffariani
Myrtus communis
Nepeta denudata
Nepeta glomerulosa
Nepeta laxiflora
Onopordon carmanicum
Onopordon leptolepis
Plathychaeta aucheri
Postia bombycina
Pulicaria gnaphalodes
Pulicaria undulata
Salvia glutinosa
Salvia hypoleuca
Salvia syriaca
Senecio coronopifolius
Seratula latifolia
Tanacetum polycephalum
Thevenotia persica
Vernonia cognata
Vernonia westiniana
Zhumeria majdae

ANNEX 10

List of Iranian Plants whose Methanolic Extracts were Used by the Microbiology Department for Antimicrobial Activity Testing

(Asterix indicates activity)

Acroptilon repens (Compositae)

Anvillea garcinii (Compositae)

Arctium lappa (Compositae)

Aristolochia bottae (Aristolochiaceae)

Artemisia absinthium (Compositae)

Artemisia annua (Compositae)

Atropa belladonna (Solanaceae)

Carthamus lanatus (Compositae)

Carthamus oxyacantha (Compositae)

Centaurea hyrcanica (Compositae)

Centaurea phaoppoides (Compositae)

Centaurea xanthocephala (Compositae)

Crupiana crupinastrum (Compositae)

Dendrostelleria lessertii (nymeleaceae)

Digitalis nervosa (Scrophulariaceae)

Eupatorium cannabinum (Compositae)

Euphorbia cheiradenia (Euphorbiaceae)

Grantia arachnoides (Compositae)

Gundelia tournefortii (Compositae)

Haplophyllum bauxbaumii (Rutaceae)

Haplophyllum perforatum (Rutaceae)

Helichrysum oligocephalum (Compositae)

Hymenocrater bituminoides (Labiatae)

Leonurus cardiaca (Labiatae)

Marrubium cuneatum (Labiatae)

Marrubium cuneatum (Labiatae)

Michauxia laevigata (Campanulaceae)

Morina persica (Morinaceae)

Myrtus communis (Myrtaceae)***

Nepeta sacchafina (Labiatae)

Onopordon leptolepis (Compositae)**

Outrega cardiforme (Compositae)**

Parrotia persica (Hamamelidaceae)

Pterocarya fraxinifolia (Juglandaceae)

Salvia aethiopis (Labiatae)

Salvia aristida (Labiatae)

Salvia hypoleuca (Labiatae)

Salvia hypoleuca (Labiatae)

Salvia multicaulis (Labiatae)***

S alvia reuteriana (Ubiatae)

Salvia sahandica (Labiatae)

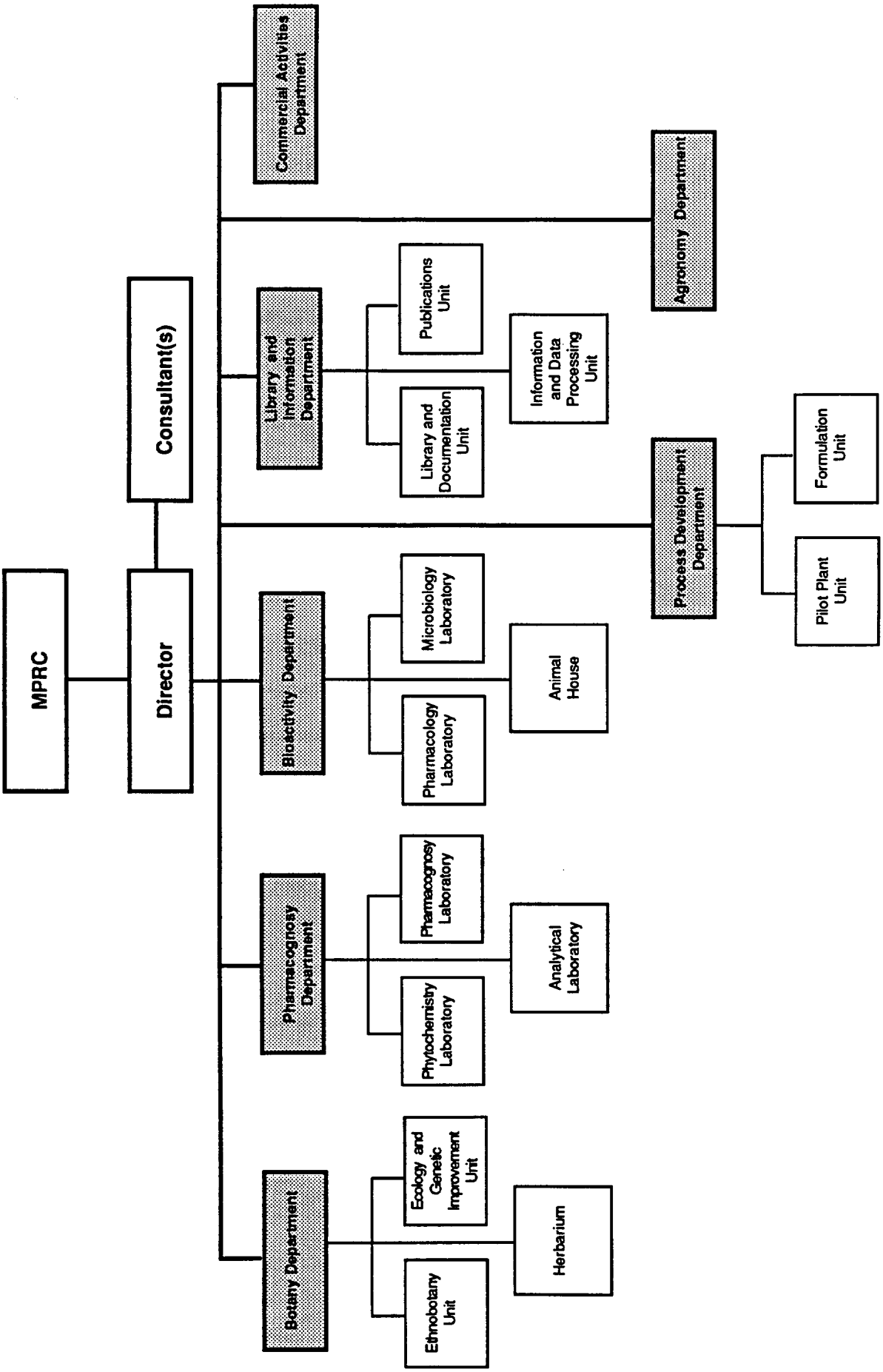
Serratula coriacea (Compositae)

Sophora alepecurdei (Leguminosae)

Stachys inflata (Labiatae)

Teucrium polium (Labiatae)

Xanthium strumorium (Compositae)***


MPRC
Director
Consultant(s)
Commercial Activities Department
Agronomy Department
Library and Information Department
Publications Unit
Information and Data Processing Unit
Library and Documentation Unit
Process Development Department
Formulation Unit
Pilot Plant Unit
Bioactivity Department
Microbiology Laboratory
Animal House
Pharmacology Laboratory
Pharmacognosy Department
Pharmacognosy Laboratory
Analytical Laboratory
Phytochemistry Laboratory
Botany Department
Ecology and Genetic Improvement Unit
Herbarium
Ethnobotany Unit

ANNEX 12

List of Journals Recommended for the Library of MPRC

(Note: Those available at the main library of the university are not included)

1. Journal of Essential Oil Research, Allured Publishing, 362 South Schmale Road, Carol Stream, IL 60188-2787, U.S.A.
2. Perfumer and Flavorist, -same as 1-
3. Cosmetic and Toiletries, -same as 1-
4. Flavour and Fragrance Journal, J.Wiley, U.K.
5. Medicinal and Aromatic Plant Abstracts (MAPA), Publications and Information Directorate, Dr.K.S.Krishnan Marg, New Delhi, 110012, India
6. Phytomedicine
7. Journal of Natural Products, American Chemical Society, U.S.A.
8. Economic Botany, U.S.A.
9. Parfums, Cosmetiques Actualites, France
10. Zeitschrift für Phytotherapie, Germany
11. Fitoterapia, Inverni della Beffa, Milano, Italy (Sent Free of Charge)
12. Manufacturing Chemist, Miller Freeman Technical Ltd., 30 Calderwood St., London SE18 6QH, U.K.
13. Soap, Perfumery and Cosmetics, Wilmington House, Church Hill, Wilmington, Dartford, Kent DA2 7EF, U.K.
14. HerbalGram, American Botanical Council, P.O.Box 201660, Austin, Texas 78720, U.S.A.
15. Zeitschrift für Arznei- und Gewuerzpflanzen, Hippokrates Verlag, Rudigerstrasse 14, 70469 Stuttgart, Germany
16. Journal of the Science of Food and Agriculture, John Wiley and Sons Ltd., Baffins Lane, Chichester, Sussex, PO9 1UD, U.K.
17. International Journal of Pharmacognosy, U.S.A.
18. Journal of Phytopharmacology

ANNEX 13

List of Books Recommended for MPRC Library

Adams, R.P., Identification of Essential Oil Components by Gas Chromatography/Mass Spectrometry, Allured, Illinois (1995)

Adams, R.P., Identification of Essential Oils by Ion Trap Mass Spectroscopy, Academic Press, London (1989).

Ahmed, M.S., Honda, G. and Miki, W., Herb Drugs and Herbalists in the Middle East, Institute for the Study of Languages and Cultures of Asia and Africa, Tokyo (1982).

Arctander, S., Perfume and Flavor Chemicals, Allured, Illinois (1969).

Arctander, S., Perfume and Flavor Materials of Natural Origin, Allured, Illinois (1960).

Atal, C.K. and Kapur, B.M., Cultivation and Utilization of Aromatic Plants, RRL-CSIR, Jammu-Tawi, India (1982).

Atal, C.K. and Kapur, B.M., Cultivation and Utilization of Medicinal Plants, RRL-CSIR, Jammu-Tawi, India (1982).

Baser, K.H.C. and Guler, N., Essential Oils for Perfumery and Flavours: Proceedings of an International Conference, 26-30 May 1990, Antalya, Turkey, AREP, Istanbul (1993).

Baser, K.H.C., Flavours, Fragrances and Essential Oils, Proceedings of the 13th International Congress, 15-19 October 1995, Istanbul, Turkey, 3 volume-set, AREP, Istanbul, Turkey (1995).

Baser, K.H.C., Honda, G. and Miki, W., Herb Drugs and Herbalists in Turkey, Institute for the Study of Languages and Cultures of Asia and Africa, Tokyo (1986).

Bauer, K., Garbe, D. and Surburg, H., Common Fragrance and Flavour Materials, VCH, Weinheim (1990).

Bisset, N.G., Herbal Drugs and Phytopharmaceuticals, Medpharm, Stuttgart (1994).

Bruneton, J., Pharmacognosy, Phytochemistry and Medicinal Plants, Intercept Ltd., Andover, U.K. (1995).

Carle, R., Aetherische Oele, Wissenschaftliche Verlag, Stuttgart (1993).

Clarke, E.G.C., Isolation and Identification of Drugs, The Pharmaceutical Press, london (1978).

Cornu, A. and Massot, R., Compilation of Mass Spectral Data, Heyden, London (Latest edition).

Cousins, D.J., Medicinal, Essential Oil, Culinary Herb and Pesticidal Plants of the Labiatae, CAB International, Wallington, U.K. (1994).

Der Manderosian, A., Natural Product Medicine - A Scientific Guide to Foods, Drugs and Cosmetics, G.E.Stickley Co., Philadelphia (1988).

Devon, T.K. and Scott, A.I., Handbook of Naturally Occurring Compounds, Academic Press, New York (1972).

Dictionary of Natural Products, Chapman&Hall, London (7 vols+3 suppl.) (1994).

Duke, James A., CRC Handbook of Medicinal Herbs, CRC Press, Boca Raton (1985).

Eight Peak Index of Mass Spectra, 3rd Edn., Mass Spectrometry Data Centre, AWRE, Adlermaston (1989).

Essential Oils and Oleoresins: A Study of Selected Producers and Major Markets, ITC-UNCTAD/GATT, Geneva (1986).

Evans, W.C., Trease and Evans' Pharmacognosy, 13th Edn., Bailliere Tindall, London (1989).

Fenaroli's Handbook of Flavor Ingredients, CRC Press, Cleveland, Ohio (1975).

Food Chemicals Codex, National Academy Press, Washington (1981).

Formacek, V. and Kubeczka, K.H., Essential Oil Analysis by Capillary Gas Chromatography and Carbon-13 NMR Spectroscopy, John Wiley, Chichester (1982)

Genders, R., The Complete Book of Herbs and Herb Growing, Ward Lock Ltd., London (1982).

Gildemeister-Hoffman, Die Aetherische Oele, Akademic-Verlag, Berlin (1966).

Govaerts, R., World Checklist of Seed Plants, Mim, Antwerp, Belgium (1995-)

Grieve, M., A Modern Herbal, Penguin Books, London (1982).

Guenther, E., The Essential Oils, Robert E.Krieger, Florida (1972)

Guide to Fragrance Ingredients. A H&R Book, Johnson, London (1985).

Harborne, J.B. and Baxter, H., Phytochemical Dictionary, Taylor and Francis, London (1993).

Hegnauer, R., Chemotaxonomy der Pflanzen, Birkhauser Verlag, Basel, 10 volumes (1962-).

Hussain, A., Major Essential Oil-Bearing Plants of India, CIMAP, Lucknow, India (1989).

Jennings, W. and Shibamoto, T., Qualitative Analysis of Flavor and Fragrance Volatiles by Glass Capillary GC, Academic Press, New York (1980).

Khan, U., Honda, G. and Miki, W., Herb Drugs and Herbalists in Pakistan, Institute for the Study of Languages and Cultures of Asia and Africa, Tokyo (1986).

Lawless, J., The Encyclopaedia of Essential Oils. The Complete Guide to the Use of Aromatics in Aromatherapy, Herbalism, Health and Well-being, Element, Dorset (1992).

Lawrence, B.M., Essential Oils: 1976-1978, Allured Publishing, Wheaton (1979).

Lawrence, B.M., Essential Oils: 1979-1980, Allured Publishing, Wheaton (1981).

Lawrence, B.M., Essential Oils: 1981-1987, Allured Publishing, Wheaton (1989).

Lawrence, B.M., Essential Oils: 1988-1991, Allured Publishing, Wheaton (1993).

Lawrence, B.M., Essential Oils: 1992-1994, Allured Publishing, Wheaton (1995).

Lawrence, B.M., Mookherjee, B.D. and Willis, B.J., Flavors and Fragrances. A World Perspective,

Elsevier, Amsterdam (1988).

Lenskens, H.F. and Jackson, J.F., Essential Oils and Waxes, Springer Verlag, Berlin (1991).

Leung, A.Y., Encyclopedia of Common Natural Ingredients Used in Foods, Drugs and Cosmetics, John Wiley, New York (1980).

Lewis, W.H. and Elvin-Lewis, M.P.F., Medical Botany, John Wiley and Sons, New York (1977).

Liangfeng, Z., Yonghua, L., Baoling, L., Biyao, L., Nianhe, X., Aromatic Plants and Essential Constituents, Peace Book Co.Ltd., Hong Kong (1993).

Liangfeng, Z., Yonghua, L., Baoling, L., Biyao, L., Nianhe, X., Aromatic Plants and Essential Constituents. Supplement 1, Peace Book Co.Ltd., Hong Kong (1995).

Martindale- The Extra Pharmacopoeia, 30th Edn., The Pharmaceutical Press, London (1993) or the latest.

Masada, Y., Analysis of Essential Oils by Gas Chromatography and Mass Spectrometry, Hirokawa Publ., Tokyo (1975).

Methods in Plant Biochemistry, Academic Press series

Modern Methods in Plant Analysis, Springer Verlag series

Official Methods of Analysis, 15th Edn., AOAC, Arlington (1990).

Pharmacopoeias - Latest editions: Such as European Pharmacopoeia, British Pharmacopoeia, French Pharmacopoeia, German Pharmacopoeia, Swiss Pharmacopoeia, Pharmacopoeia of Japan, Pharmacopoeia of India, United States Pharmacopoeia and national formulary.

Rastagi, R.P., Compendium of Indian Medicinal Plants, CDRI, Lucknow, India (1991).

Remington's Pharmaceutical Sciences, Latest Edition, Mack Publishing Co., Easton, Pennsylvania, U.S.A.

Robbers, J.E., Speedie, M.K. and Tyler, V.E., Pharmacognosy and Pharmacobiotechnology, Williams and Wilkins, Baltimore (1996).

Sandra, P. and Bicchi, C., Capillary Gas Chramotagraphy in Essential Oil Analysis, Alfred Huethig Verlag, Basel (1987).

Schauenberg, P. and Paris, F., Guide to Medicinal Plants, Butterwort, London (1977).

Srinivas, S.R., Atlas of Essential Oils, Anadams, New York (1986).

Swigar, A.A. an Silverstein, R.M., Monoterpenes: Infrared, Mass, 1H NMR and 13C NMR Spectra and Kovats Indices, Aldrich, Milwaukee (1981).

Tetenyi, P., Infraspecific Chemical Taxa of Medicinal Plants, Akademia Kiado, Budapest (1970).

Thompson, R.H., The Chemistry of Natural Products, Blackie&Son, Glasgow (1985).

Tyler, V.E., Brady, R., Robbers, J.E., Pharmacognosy, 8th Edn., Lea and Febiger, Philadelphia (1981).

Valnet, J., Aromaterapie Traitment des Maladies par les Essences des Plantes, Maloine, Paris (1990).

Verghese, J., On Essential Oils, Synthite, India (1986).

Vernin, G., The Chemistry of Heterocyclic Flavouring and Aroma Compounds, Ellis Horwood, Chichester (1982).

Wallis, T.E., Textbook of Pharmacognosy, J. and A. Churchill Ltd., London (1967).

Wijesekera, R.O.B, Practical Manual on the Essential Oil Industry, UNIDO, Vienna

Wijesekera, R.O.B., The Medicinal Plant Industry, CRC Press, Boca Raton (1991).

Wiley/NBS Mass Spectral Data Base, Wiley, New York (Latest edition).

Wren, R.C., Potter's New Cyclopedia of Botanical Drugs and Preparations, C.W.Daniel Co., Essex, U.K. (1975).

Yukawa, Y. and Ito, S., Spectral Atlas of Terpenes and the Related Compounds, Hirokawa, Tokyo (1973).

Total Area Under Harvesting in 1996 at the Fields of Jahad Daneshgahi

Plant Name	Sq.m.Area under cultivation
Thymus vulgaris	2,000
Bunium sp.	2,000
Coix lacrima var. *okavama*	2,000
Linum usitatissimum	2,000
Borago officinalis	2,000
Carthamus tinctorius	3,000
Nigella sativa	4,000
Plantago psyllium	4,000
Rosmarinus officinalis	4,000
Ocimum basilicum	6,000
Anthemis nobilis	6,000
Pimpinella major	6,000
Calendula officinalis	6,000
Lavandula angustifolia	6,000
Coriandrum sativum	6,000
Physalis alkekengi	6,000
Foeniculum vulgare	6,000
Carum copticum	8,000
Salvia sclarea	10,000
Hyssopus officinalis	12,000
Mentha piperita	14,000
Anethum graveolens	20,000
Melissa officinalis	30,000
Cucurbita pepo var. *styrrata*	40,000

ANNEX 15

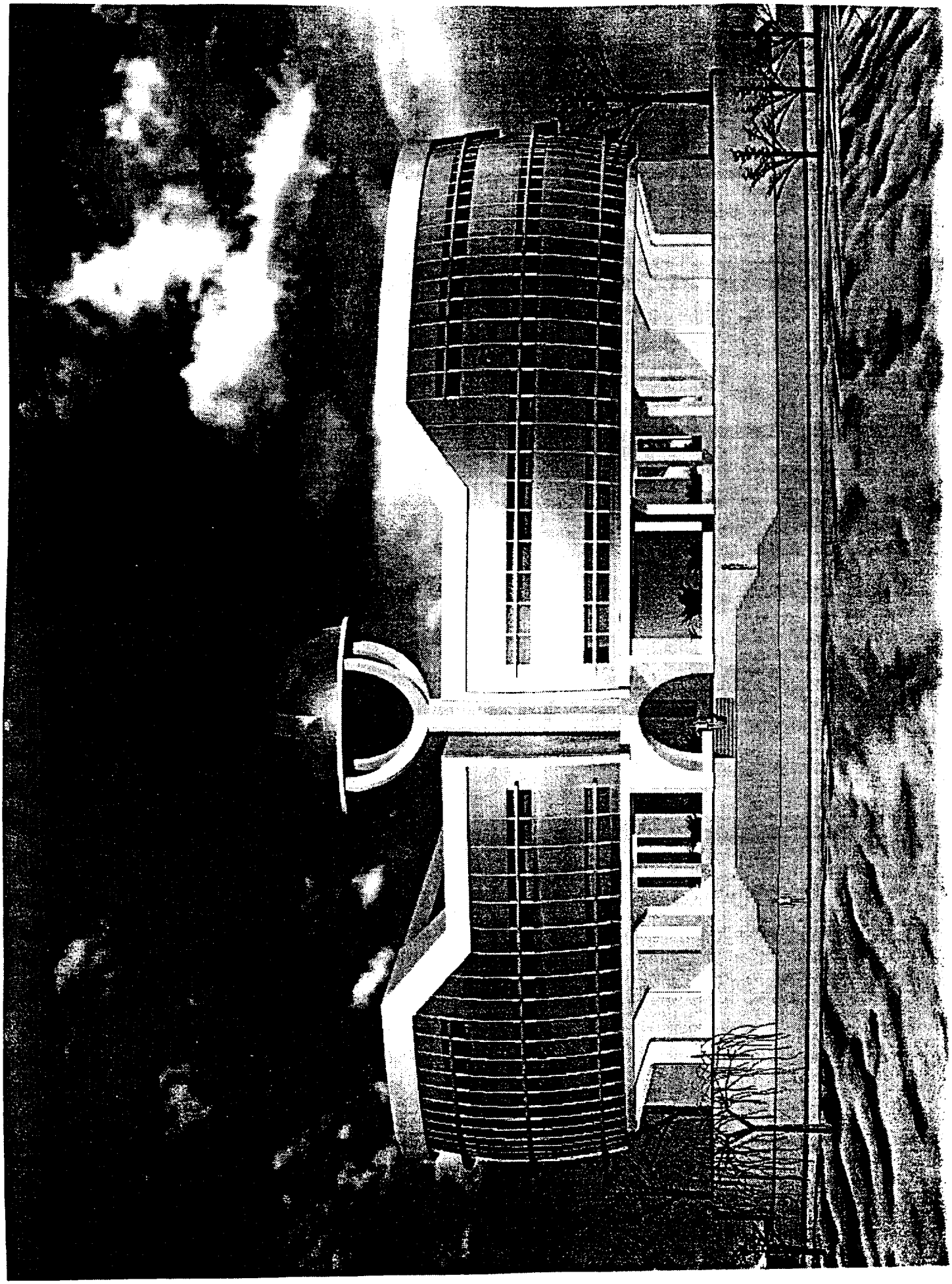
Medicinal and Aromatic Plants Cultivated in 6 sq.m Plots in Jahad Daneshgahi in 1996. (figure in paranthesis shows the number of plots)

Althaea officinalis
Althaea sp. (x2)
Amsonia tabernaemontana
Anethum graveolens
Angelica archangelica (x2)
Anthemis nobilis
Atropa belladonna (x2)
Borago officinalis
Calendula officinalis (x3)
Carthamus sp.
Carthamus tinctorius (x4)
Carum carvi
Carum carvi cv. Bleija
Carum carvi cv. Vohl
Carum copticum
Cassia senna
Catharanthus roseus
Cichorium intybus
Coix lacrima
Coriandrum sativum
Cucurbita ficifolia
Datura innoxia
Datura metel
Datura metelioides
Datura stramonium
Digitalis lanata
Digitalis purpurea
Dracocephalum moldavica (x2)
Filipendula vulgaris
Foeniculum vulgare (x2)
Foeniculum vulgare cv.GV (x2)
Helenium autumnale (x2)
Hyoscyamus albus
Hyoscyamus niger
Hypericum perforatum (x3)
Hyssopus officinalis (x2)
Inula helenium (x2)
Lavandula angustifolia (x3)
Levisticum officinalis
Linum usitatissimum
Lycopus europeus
Malva sylvestris (x2)
Matricaria chamomilla (x2)
Melissa officinalis (x2)
Mentha piperita (x2)
Mentha spicata
Nepeta cataria
Nigella sativa (x2)
Ocimum basilicum (x2)
Oenothera lamarchina
Origanum vulgare
Papaver somniferum (x2)
Plantago lanceolata
Plantago ovata
Plantago psyllium (x2)
Plantago sp. (x2)
Ricinus communis (x3)
Rosmarinus officinalis
Ruta graveolens (x3)
Salvia officinalis
Satureja hortensis
Sicyos angulata
Silybum marianum (x4)
Solanum laciniatum
Solidago ambigua
Stachys officinalis
Tanacetum cinerariaefolium
Tanacetum macrophyllum
Tanacetum parthenium
Tanacetum vulgare
Teucrium polium
Thymus vulgaris
Valeriana collina
Verbascum phlomoides

A Priority List of Plant Species for Possible Developmental Work at MPRC

Type	Plant species	Common name	Plant part	Product
A/F	*Anethum graveolens*	Dill	herb, fruit	E.O.
A	*Artemisia dracunculus*	Tarragon	leaves	E.O.
M	*Atropa belladonna*	Belladonna	leaves, roots	extract
A	*Bunium persicum*	Siah Zeera	fruits	E.O.
M	*Cassia acutifolia*	Senna	leaves, fruits	extract
M	*Chrysanthemum cinerariaefolium*	Pyrethrum	flowers	extract
M	*Cucurbita pepo* var. *styrrata*	Pumpkin	seeds	fixed oil
A	*Ferula galbaniflua, F.gummosa*	Galbanum	oleoresin	E.O./resin
M.	*Glycyrrhiza glabra*	Liquorice	roots	extract
A/F	*Heracleum persicum*	Golpar	fruits	E.O./extract
M	*Hyoscyamus muticus*	Egyptian Henbane	plant	extract
M	*Hypericum perforatum*	St.John's wort	flowering herb	extract
A/M	*Melissa officinalis*	Melissa	leaves	E.O.
A	*Myrtus communis*	Myrtle	leaves	E.O.
M	*Oenothera lamarchina*	Evening primrose	seeds	fixed oil
A	*Pelargonium roseum*	Geranium	leaves	E.O.
M	*Plantago psyllium*	Psyllium	seed coat	as such
A	*Rosa damascena*	Rose	flowers	E.O./extract
A	*Rosmarinus officinalis*	Rosemary	leaves	E.O./extract
A	*Zataria multiflora*	Zataria	herb	E.O.

A= Aromatic, F=Food additive, M=Medicinal, E.O.=Essential oil



ANNEX 18

TENTATIVE BUDGET OF A POSSIBLE PROJECT

Title: Strengthening of the Medicinal Plant Research Centre

Duration: 3 years

Executing Agency: UNIDO

Implementing Agency: The Medicinal Plant Research Centre of the Shahid Beheshti University

Project Total: US$ 1.896.000

Experts	**m/m**	**US $**	**Total US$**
International experts	20	15,000.00	300,000.00
Short term international experts	3	15,000.00	45,000.00
Local experts	10	2,000.00	20,000.00
Mission costs			12,000.00
Total expert component	**33**		**377,000.00**
Training			
Fellowships	40	5,000.00	200,000.00
Study tours			50,000.00
Training workshop			25,000.00
Total training component	**40**		**275,000.00**
Equipment			
Non-expendable equipment			1,126,000.00
Expendable equipment			100,000.00
Total equipment component			**1,226,000.00**
Miscellaneous			30,000.00
Project total	**73**		**1,908,000.00**

ANNEX 19

PROVISIONAL LIST OF EQUIPMENT

Non-expendable Equipment

	Pilot Plant Equipment	Estimated cost (US$)
1.	Multipurpose pilot plant and spares (500 L cap.)	250,000.00
2.	Cabinet dryer (50-100 kg/batch)	
	Hammer mill (50 kg/h)	
	Buchner type vacuum filter (20 L)	20,000.00
3.	Multistage liquid-liquid extractor (100 L/h cap.)	50,000.00
4.	Glass lined reactor (100 L cap.)	50,000.00
5.	All-glass fractionating column (1 L)	30,000.00
6.	Platform balance (200 kg)	2,000.00
7.	Climbing film evaporator (10 L/h)	20,000.00
8.	Flash evaporator (50 L/h)	30,000.00
9.	Basket centrifuge (S/S, basket dia.450 mm, ex-proof motor)	5,000.00
10.	Filter press (S/S, 600x600 mm, 10 plates/frames, ex-proof)	10,000.00
11.	Spray drying pilot plant (20 kg/h water evapn.cap.)	100,000.00
12.	Storage tanks	10,000.00

Maintenance Equipment

13.	Turning lathe (5 ft bed)	
14.	Portable drilling machine	
15.	Pedestal drilling machine	
16.	Portable grinding/cutting unit	
17.	Argon arc welding set	
18.	Oxy-acetylene cutting/welding set	
19.	Motorized hacksaw	
20.	Hydrolic pipe bender (manually operated)	
21.	Mechanical tools	
22.	Stainles steel (S/S) sheets, pipes, valves	
23.	Glass blowing equipment for simple repairs	
	Total	30,000.00
24.	Sundries and expendables	10,000.00

Equipment for Pharmacognosy Laboratory

25.	Rotary evaporators with vacuum regulators+pumps (2 pcs)	5,000.00
26.	UV/VIS double-beam scanning spectrophotometer	20,000.00
27.	Gas liquid chromatograph with FSC columns, FID, TCD, ECD detectors, integrator, split/splitless injector, all necessary accesories and spares	30,000.00
28.	High pressure liquid chromatograph with column oven, automatic injector, detectors (RI, UV/VIS, conductivity, fluorescence, photo-diode array), 3xpumps, integrator, packed columns, accessories, spares	50,000.00

29.	TLC scanner	20,000.00
30.	Bench-top spray dryer	20,000.00
31.	Freeze-dryer	30,000.00
32.	Auto-titrator	10,000.00
33.	Electronic balances (Top loading: 2 pcs, Analytical: 3 pcs)	10,000.00
34.	Vacuum pumps (2 pcs)	5,000.00
35.	Abbe type refractometer	5,000.00
36.	Electronic polarimeter	3,500.00
37.	Laboratory Centrifuge (10.000 rpm with tubes and rotors)	800.00
38.	Ultrasonic bath 400	
39.	Microscopes (binoculars and stereo: 2 pcs each)	5,000.00
40.	pH meter/conductometer set with electrodes	1,500.00
41.	Heating mantles (10 pcs)	1,100.00
42.	Hot plate/magnetic stirrer (5 pcs)	500.00
43.	Circulating thermostatic water bath	2,500.00
44.	Water baths (6-lid, 3 pcs)	500.00
45.	Flask shakers (5 pcs)	900.00
46.	Vacuum oven with vacuum pump	2,000.00
47.	Drying ovens (2 pcs)	1,000.00
48.	Moisture balance	2,000.00
49.	Water still (10 L/h)	2,000.00
50.	Water deionizer (300 L/h)	800.00
51.	Glass Soxhlet extractors (various sizes, 20 pcs)	2,000.00
52.	Glass Clevenger apparatus (10 pcs)	1,000.00
53.	Buchner filtration setup	200.00
54.	Hot air blower	100.00
55.	Deep freezer	1,000.00
56.	Chromatography columns	300.00
57.	Laboratory glassware	5,000.00
58.	Chemicals, solvents and other expendables	30,000.00
	Biological Activity Department	
59.	Hippocratic screening equipment	50,000.00
60.	Gamma counter	20,000.00
61.	Cold room (+5/-5°C, 5 cubic meter)	5,000.00
62.	Laminar flow cabinet	5,000.00
63.	Microscopes (Res.:2, Stereo:2)	6,000.00
64.	Centrifuge	2,000.00
65.	Autoclave	1,000.00
66.	Deep freezer	500.00
66.	Chemicals, laboratoryware and expendables	30,000.00
	Botany Department	
67.	Microscopes (Research: 2, Stereo: 3)	7,500.00
68.	Global Positioning System	1,000.00
69.	Deep freezer (-18°C/-30°C) (2 pcs)	1,000.00
70.	Dissection sets, altimeters, expendables	10,000.00
	Audio/visual, Printing and Office Equipment	
71.	Word processors (3 pcs) + printer + laser printer	12,000.00
72.	Personal computers (10 pcs) + printers (5 pcs)	15,000.00
73.	Photocopiers (3 pcs)	10,000.00
74.	Slide projectors (2 pcs)	3,000.00
75.	Overhead projectors (one portable) (2 pcs)	2,000.00
76.	Video-projection system (portable)	7,000.00

77.	Video camera outfit + accessories+spares +consumables	10,000.00
78.	Photographic camera + accessories	750.00
79.	Large screen TV set	1,500.00
80.	Video recorder/player	750.00
81.	Portable sound recording outfit	500.00
82.	Drafting table + drafting tools	500.00
83.	Books	20,000.00
84.	Project vehicles (4-wheel drive) (2 pcs)	70,000.00
	Total	1,176,000.00
	Expendables	50,000.00
	TOTAL EQUIPMENT BUDGET	**1,226,000.00**

PROJECT MANAGER'S COMMENTS

The consultant has gathered relevant information from local industries producing plant based products, University departments and Research Institute officials of the Ministry of Industries and the Shahid Beheshti University and assessed the needs and the requirements for setting up of the Medicinal and Aromatic Plant Research Centre. His comprehensive report contain the current state of development of the plant based industries and recommendations for setting up of the Centre . The Government and the University have already committed funds for the construction of a building to house the Centre. The requirements in terms of equipment and training have been identified and estimated. The Project Manager in charge at UNIDO has agreed with the recommendations of the consultant and made presentations to the authorities at the Shahid Beheshti University and Ministry of Industry on the comparative advantages of requesting UNIDO to implement the project which is to be financed by the Government. The long experience of UNIDO in setting up this type of Centres in developing countries could be used by the Islamic Republic of Iran in setting up of an excellent Centre which could not only be successful in initiating viable industries in the country but also in supporting technical cooperation among developing countries.

It is hoped that the Government of the Islamic Republic of Iran and the Shahid Beheshti University will soon accept the recommendations and request UNIDO to prepare a project document for implementation.