

**MOROCCO**  
**HERBAL AND MEDICINAL PLANTS PROJECT (HMPP)**  
**Supervision Mission**  
**January 22-29, 2006**

**Aide Memoire**

1. A mission from the United States Department of Agriculture, Agricultural Research Service (USDA-ARS), comprised of Ibrahim Shaqir, International Affairs Specialist, OIRP, Beltsville, MD; Edward Garvey, Plant Exchange Officer, NGRL, Beltsville, MD; and Charles Cantrell, Research Chemist, Natural Products Utilization Research Laboratory, Oxford, MS, and Mohamed El-Mourid, Regional Coordinator, (ICARDA, North Africa Regional Program) visited the *Institut National de la Recherche Agronomique* (INRA), Rabat, Morocco from 22-29 January 2006 to launch the Herbal and Medicinal Plants Project .
2. The mission wishes to thank Drs. Hamid Narjisse, Director of INRA, Imane Alami Thami, Head of the Regional Center of Agronomic Research of Rabat, Chaouki Alfaïz, Coordinator of the HMPP project, and all the INRA staff for the well-organized tours, meetings, hospitality and generosity. Appreciation is also extended to Dr. Mohamed El-Mourid, North African Regional Coordinator from the International Center for Agricultural Research in the Dry Areas (ICARDA) and his staff for organizing the visit and the numerous fruitful meetings.
3. The HMPP supports and enhances existing research and extension programs at INRA on Medicinal and Aromatic plants (MAP's).
4. On January 24, 2006, Drs. Thami and Alfaïz led the U.S. visitors on a field tour to visit MAP activities in Khémisset, Oulmes and the INRA-Marchouch research station. At Khémisset, we visited the on-farm trial plots of a farmer cooperating with INRA on the MAP project. The farmer expressed his interest in finding alternative crops and was very optimistic about the the feasibility of producing selected medicinal plants on his farm. At Oulmes, the team met with Mr. Aouragh El Hachmi (Retired INRA researcher) who gave a guided tour to his farm and then a the nearby lavender cultivation area that has spread to over 1200 ha concentrated on the plateau in the Oulmes region. Finally, the Mission visited the INRA research center at Marchouch where we were shown the medicinal plant trail plots.
5. The Mission visited the research trials planted for the purpose of evaluating feasibility of domestication (*thyme, oregano, muscari, and chamomile*) by testing germination, soil structure, fertilization effect, and for seed production and nursery evaluation. The three sites were planted with *cumin, black cumin, fennel, and coriander* (See table 1 & 2). The plants at all of the research trials we visited were in the early stages of growth, and mostly rain-fed.
6. On January 25, 2006, the Mission traveled to INRA, Regional Center of Agronomic Research (CRRA) of Settât, accompanied by Dr. Al Faïz. At Settât, we were welcomed by Dr. Mohamed El-Gharous, Director, CRRA, Settât. After an introduction to the staff, we visited the National Genebank of Morocco, located at CRRA. Dr Hassan Ouabbou, Head of the genebank, gave the team a tour of the genebank facilities and the genebank database. The Mission team then visited a nearby MAP production farm, operated through a farmer co-operative and toured the research evaluation plots. The mission did not visit the proposed *in-situ* conservation site due to the inclement weather. Settât is located in the dry areas of Morocco, where the MAP project will focus on targeted species that are drought tolerant.

7. On January 26, 2006, Dr. Narjisse presided over the HMPP workshop at INRA Headquarters, Rabat. The purpose of workshop was to bring the project cooperators up to date and accentuate the HMPP project components, future plans, and to recommend a list of priorities and next steps. The workshop commenced with a welcome by Dr. Narjisse and then with presentations by Mr. Shaqir, Dr. Garvey and Dr. Cantrell and followed by presentations by INRA's MAP project cooperators: Drs. Alfaiz, Mohamed Bouffirass, and Driss Hadarbach. INRA presenters gave an overview of the project progress to date and the 2006 work plan. After the presentations, the participants were divided into 3 breakout groups/sessions. The 3 sessions were genetic resources, HMP agronomic aspects (management of HMP production, and sustainable use and conservation), and Socio-Economic. The teams discussed each of their respective areas at length, and presented their recommendations at the end of the workshop. As a result of the breakout sessions a list of next steps and recommendations were generated (Appendix 1).
8. Over dinner hosted by Dr. Narjisse, the Mission met with the representative of the USDA at the U.S. Embassy, Rabat, Mr. Michael Fay, Agricultural Attaché, USDA Foreign Agriculture Service (FAS), where the Mission took the opportunity to update him on progress and future plans.
9. As a result of our discussion with the INRA MAP project coordinators and Dr. El Mourid, ICARDA, concerning the project millstones and the overall progress, we recommend that the project end date be extended to September 30, 2008. Thus the project coordinators will have to send a letter requesting a "No Cost Extension" to USDA-FAS, in order to extend the project to insure all components and project millstones are accomplished.
10. On the morning of January 27, 2006, the Mission met at the hotel with Dr. El Mourid, ICARDA, and Drs. Thami and Al Faiz, INRA, to wrap-up our visit and discuss future plans and missions. The mission recommended a close cooperation be established with the Institut de Regions Arides (IRA), Tunisia, as they have worked on a similar project to the HMPP- Morocco and INRA may benefit from the knowledge and lessons learned. The Tunisian experience will benefit INRA HMPP cooperators and will help them in all aspects of the project. As a result, the Mission suggested a visit to Tunisia by the HMPP project coordinator Dr. Al Faiz , and for it to take place as soon as possible.
11. The INRA and ICARDA project cooperators indicated that they are interested in conducting chemical analysis on selected medicinal plants and they would like to have the testing done at INRA laboratories in Rabat, and requested form the mission to assist in this effort to insure that proper instruments are in place. Dr. Cantrell agreed to take the lead in this effort due to his expertise. Dr. Cantrell recommended that certain equipment, supplies, infrastructure, and training are essential to conduct chemical analysis of medicinal plants at INRA. Certain experimental plots of medicinal and aromatic plants that are currently growing in Morocco may benefit from chemical analysis of marker compound(s) and/or oil analysis. In particular, when trying to select a particular cultivar, location, and/or population to accelerate forward in subsequent years, this information will aid in choosing the optimal line (See Appendix 1).
12. As *in situ* and *ex situ* conservation of cultivated and indigenous plant genetic resources of the targeted herbal and medicinal plants are key components of the HMPP, the INRA and ICARDA project coordinators indicated that they are interested in establishing close collaboration with the US National Plant Germplasm System. Particular areas of

collaboration could include providing literature on genebank management activities such as seed testing, seed storage techniques, seed regeneration, etc., Other areas of collaboration could be training in the US in genebank management and joint participation in plant explorations in the HMPP and others explorations in Morocco and the US. The US is also committed to continue existing efforts to repatriate NPGS germplasm originating in Morocco. Identifying and obtaining funds will be necessary to support the training efforts and US participation in HMPP plant explorations and additional plant explorations in Morocco and the US. In addition, a Material Transfer Agreement (MTA) to identify the rights and ownership issues of exchanged genetic resources in accordance with the UN Convention on Biological Diversity and the policies of INRA and ARS must be signed by appropriate representatives of both countries. Dr. Garvey endorsed the collaboration and agreed to take the US lead in this endeavor. He will work with Dr. Hamid Narjisse, Director of INRA to develop the MTA and obtain Moroccan national access permission and with other US programs to obtain training funds.

Moreover, ICARDA Genetic Resources Unit is available to collaborate with INRA and ARS and help in the collection missions and training.

13. **Project objectives:** The overall objective of the project is to support the conservation, management, and sustainable utilization of medicinal and herbal plants in Morocco while ensuring effective *in situ* protection of threatened habitats and ecosystems. The project's specific objectives are to:

- a. Prepare a national database on indigenous medicinal and herbal plants, with a view to assess their usage, status, and ecosystems;
- b. Conserve, manage, and sustainable use, both *in situ* and *ex situ*, medicinal, herbal and aromatic plants in arid and semi-arid areas;
- c. Institutionally strengthen collaborating agencies, i.e. scientific research institutes, faculties of pharmacy, extension services, universities, NGOs, etc. to add value to medicinal herbal and aromatic plants through processing, chemical analysis and marketing;
- d. Improve public awareness of the importance of medicinal plants and build on traditional knowledge and cultural heritage.

14. **Project description:** The HMPP project will support the conservation, management, and sustainable utilization of medicinal and herbal plants in Morocco while ensuring effective *in situ* protection of threatened habitats and ecosystems. The project will be managed from two locations; INRA Settât and the focal point will be in INRA, Rabat. In addition, MAP production sites will be in the following locations of Morocco: Safi, El Kalaâ, Chichaouia, Errachidia, Marrakech, Sidi Kacem, El Hajeb, Taliouine, Safi Gharb, Settât, and Oulmès. These sites were selected because of their diverse ecological characteristics and also characterized by large rainfed grain farms. Because of the lack of income alternatives in this area, these regions will be severely affected as the Free Trade Agreement (FTA) eventually results in increased imports of US grains and pulses. Medicinal plants offer one of the few viable cropping alternatives to grains in these areas. This project is an extension of an on-going project in Tunisia, and is envisioned to extend further to other arid and semi-arid countries in the region. The Morocco Medicinal Plants Project is funded with PL480 Section 108-d (marketing) Moroccan Dirhams. Current and future project activities will be organized according to the following components:

15. **Component 1: Socioeconomic analysis.** The aim of this component is the following: to assess the degree of cultivation, marketing and processing; and identify constraints to the sustainable development of the sector; and assess the cultural role of medicinal and herbal plants; and make recommendations for research, policy and management. This component requires a social, economic, and market analysis at the international, national and local level. However, the national and local study will be conducted first and lastly the international market study will be conducted. As a result of the breakout session discussion, it was agreed that the local study will be limited to Marrakech and Essauira regions, and should be finalized by December 2006. The team conducting the study will summarize existing information and analyze current consumption and use, farming systems and marketing channels for producing and selling herbal and medicinal plants.
16. **Component 2: Genetic resources management.** The goal of this component is to attain the following: To collect and conserve the selected species; identify endangered species; identify niches of biodiversity for in-situ conservation; assess a herbarium and establish a database; assess genetic variability; and identify promising genotypes with chemical and medicinal properties. The project will: (a) collect and conserve herbal and medicinal plants by means of both *ex-situ* and *in-situ* methods for plant genetic resource conservation; (b) develop a database, and (c) multiply plant materials that will enable them to be tested in practical systems of production (Component 3).
17. **Component 3: Production and processing.** The goal of this component is to achieve the following: to assess the viability of cultivation, marketing and processing; identify constraints to the sustainability of this sector. For each of the target species, the following is required: (a) agronomic research to be conducted to produce the selected plants on farm scale; (b) product development and marketing (collaboration with food scientists, chemists, vegetable wholesalers for fresh or dry plant materials); and (c) conservation for each of the species (inventory, *in-situ* and *ex-situ* monitoring, collection, multiplication).
18. **Project cost and financing:** The total project budget is estimated at about USD \$292,600. Funds are managed by ICARDA Rabat Office.
  - a. As field work is important in this project, it is recommended to buy a second car. For this, 21 000 US\$ allocated for processing equipment will be reallocated for the second car, understanding that INRA will provide funds for the needed processing equipment on its own budget.
  - b. For the first year, the total expenses were: **25,757.85 US\$** (tables 5&6 appendix 3).
  - c. The available remaining funds as of January 1<sup>st</sup>, 2006 are: **266,842.00 US\$** to be reallocated between January 2006 and September 2008
19. **ICARDA Backstopping:** during 2005, ICARDA helped in starting the project activities in the following areas:
  - a. Development of Plan of Work for the whole period and for the first year
  - b. Development of a proposal on IPM in the mint crop

- c. Attending different meetings of the team
- d. Supporting two INRA scientists to attend the international conference on agro biodiversity at ICARDA Aleppo April 2005
- e. Management of the funds and acquiring equipment for INRA

For the up coming activities, ICARDA scientist will assist in the area of socioeconomics, genetic resources/agro biodiversity, IPM, agronomy, training and scientific meetings, international marketing, coordination and management.

**Table 1: Cultivated target species**

<b>Species</b>	<b>Production area</b>	<b>Justification</b>
Cumin	Safi, El Kalaâ, Chichaouia, Errachidia, and Marrakech	Cash crop, drought tolerant
Fennel	Sidi Kacem, and Chichaoua	Cash crop
Anis	El Hajeb	Cash crop
Lavender	Oulmès	Well adapted
Saffron	Taliouine	High prices
Fenugreek	Sidi Kacem, Safi Gharb, and Settât	Drought tolerant
Coriander	Safi, Gharb, and Settât	Cash crop
Cress & black cumin		Cash crop

**Table 2: Candidate species for domestication**

<b>Species</b>	<b>Potential production area</b>	<b>Justification</b>
Thyme	Mountains and highlands	Threatened, high commercial value
Oregano	Favorable rainfed	overexploited
Muscari	Semi arid	Overexploited High commercial value
Moroccan chamomile	Coastal area (Rabat-Larache)	Overexploited

**Appendix 1: Next steps matrix**

<i>Item</i>	<i>By whom</i>	<i>Action Schedule (2006)</i>
Send CVs of selected Chemists to Dr. Cantrell, USDA in preparation of scientific cooperation and training	INRA/ICARDA	1 March
It is recommended that INRA MAO project coordinators visit IRA Tunisia and relevant MAP activities in the north of Tunisia	INRA Project Manager, ICARDA	1 May
Initial socio-economic studies		
Local	Socio-econ Team Leader	31 December
National	Consultant from MOA	31 December
International	USDA-ARS-OIRP/NAL ICARDA, Consultant	NAL literature search by 1 July; Market study by
Establish a MAP Plants database	INRA	1 September
Prepare for a National Workshop for MAP stakeholders	INRA Project Manager, and ICARDA	2006-2007 (???)
Summarize Moroccan projects with relevance to the HMPP	INRA Project Manager	1 May
Establish a website that describes the HMPP project	USDA-ARS-OIRP	1 June
Collection and review of Moroccan and regional MAP literature	INRA Project Teams ICARDA Researcher	Collection 1 August Review 1 December
Submit progress and annual reports, financial report to ICRDA	INRA Project Manager, ICARDA	July 15
Prepare USDA-FAS-ICD-RSED- Cochran Fellowship	USDA-ARS & INRA and ICARDA	1 September
Submit a "No cost extension" request to modify the end date to September 2008.	INRA/ICARDA	1 March
Next Supervision Mission	USDA-ARS	April 2007

## **Appendix 2: Terms of Reference (TOR) for Component Activities**

### **1) Socio-Economic Survey**

The survey will assess the supply and demand of medicinal plants used for human and livestock healthcare needs. Social and economic aspects will be emphasized. For the sociological work the following will be accomplished: (i) rural community use and dependency of residents on medicinal plants and traditional knowledge of their use, including major species used (human and livestock), frequency, sustainability of supply and cost; and (ii) urban use that will focus on major species used (human), availability and volume of raw materials, origin (local, imported), traded, consumers, cost. Economic aspects of markets for herbal and medicinal plants should study prices, imports, exports or potential for trade at the local, national and international levels. The role of women in collecting and purchasing herbal and medicinal plants in urban markets should be identified.

The team should include: a resource economist, botanist, ethno-pharmacologist, and a systems production specialist. The consultant or team should suggest ways in which the project can address problems of supply and demand, community collaboration and participation in identifying strategies for conservation and management of reserves and wild resources. The following factors need to be examined:

#### **Market factors:**

1. Size (number of vendors) and prospective growth of the herbal and medicinal plant market,
2. Marketing and distribution infrastructure (
3. Export sales potential
4. Major herbal and medicinal species used and associated crops in the market;
5. Source (free, purchased);
6. Origin of materials (local, outside region); if outside region, from where;
7. Volumes per species or parts thereof;
8. Value (cost per gram per species or parts thereof);
9. Major market locations in southern Tunisia;
10. Clientele (women, men, other traders, pharmaceutical companies, herbal processors/herbalists);

#### **Production factors:**

1. Availability (seasonal, year round) and cost of local herbal and medicinal plants, water and other non-labor inputs;
2. Availability (seasonal, year round) and cost of herbal and medicinal plants from other countries;
3. Transportation, port and warehousing facilities;
4. Vendor gender, age, knowledge, background;
5. Approximate volume of plants materials available for sale;
6. Days per week markets open;
7. Source of raw materials (local and imported);
8. Availability of supplies;
9. Preference (Moroccan, imported);
10. Industrial uses and magnitude of production (pharmaceutical, cosmetic and food uses)

It is important for the team conducting the socio-economic study, to keep in mind the two project context: a) The FTA, and how farmers will improve their income by farming medicinal and

aromatic plants, and adoption or improvement; b) and the proposition of a “development project for investment in this sector”, which should be submitted to funding agencies.

The team will prepare a budget for field activities, data analysis and report writing. To include:

- days expected in the field; number of field personnel; per diems (accommodation, meals); field transportation costs; collecting, identification, specimen drying, storage costs; data analysis and report writing (days).

## 2) Genetic Resources Activities

The collection and conservation of indigenous crop genetic resources of medicinal, herbal and aromatic plants of Morocco is one of the fundamental components of this project. The staff of INRA in both Rabat and Settat has carefully considered which target plants and geographic regions for collection and conservation. Fortunately, INRA staff associated with this project has been working with a number of MAP plants for several years now and have been able to focus conservation and collection areas to key locations and target species.

The plan of work is as follows:

1. *In situ* conservation: Work with the Forestry Department to identify two areas for protection. These areas must be genetically rich in diversity of the target species and also areas where grazing by animals and land development is prohibited and this restriction can be enforced.
2. *Ex situ* collection and conservation: Three regions and locations within the regions have been identified for collection activities. Target species from each region are also identified. Over the course of this project 4 plant collections will be undertaken.

### **Collection 1: Collection of seeds and plants of aromatic and medicinal plants in the Rif Mountains.**

Objective: Collect seeds of Oregano and Thyme from the North region of Morocco for conservation and domestication.

Target Plants: *Origanum elongatum*, *Origanum compactum*, *Origanum grosi*, *Thymus capitatus*, *Thymus serpyllum*, *Thymus vulgaris var. capitellatus*

Collection sites: Ouezzan, Chaouen, Targuist, Al Houceima, Taza.

Duration: 5 days, 4 nights, 5 researchers (maximum).

Collection time: week of November 7-13.

#### Budget:

Expenses	Unit Price	Total (Dirhams)
Gasoline	1,500	2,000
Perdiem ( 5 researchers x 5 days)	300	7,500
Hotel ( 5 researchers x 4 nights)	300	6,000
Total		15,000

Researchers: C. Alfaiz, H. Ouabbou, N. Saïdi, Thami Alami, Hilali

**Collection 2.** Collection of seeds and plants of aromatic, medicinal species in the Central Region and identification of sites for *in situ* conservation

Target plants:

- *Thymus broussonetii* (Rabat et Essaouira)
- *Thymus satureioides* (Azilal et Agadir)

- *Tymus maroccanus* (Oulmès)
- *Muscari comosum* (Had Goualem et Khouribga)
- *Ormenis mixta* (Maâmora et Gharb)
- *Laurus nobilis* (Beni Mellal et Moulay Abdeslam)
- *Origanum compactum* (Rabat et Ouezzane).

Collection areas: Forêt de Benslimane à Roummami, Oulmès, Maâmora, Azilal, Ouezzane, Moulay Abdeslam et Azrou.

Collection times: Two periods: March 2006 to collect plants and bulbs, July 2006 to collect seeds.

Budget:

Expenses	Unit Price	Total (Dirhams)
Gasoline	3,000	3,000
Perdiem ( 10 researchers x 3 days)	9000	9,000
Hotel ( 10 researchers x 2 nights)	6000	6,000
<b>Total</b>		<b>18,000</b>

Researchers will divide into 2 different teams:

Team I		
<i>Thymus broussonetii</i> (Rabat) <i>Tymus maroccanus</i> (Oulmès) <i>Origanum compactum</i> (Rabat & Ouezzane). <i>Laurus nobilis</i> (Moulay Abdeslam)	Alfaïz C. Thami Alami Taleb Hilali H. Benaoda	Ressources génétiques Ressources génétiques Identification Enquêtes Socio- économie Etude ago-écologique
Team II		
<i>Muscari comosum</i> (Had Goualem et Khouribga) <i>Thymus satureioides</i> (Azilal) <i>Ormenis mixta</i> (Maâmora et Gharb) <i>Laurus nobilis</i> (Beni Mellal) <i>Origanum compactum</i> (Beni Mellal)	N. Saïdi H. Ouabbou Moutiq Boutfirasse Boughlala	Identification Ressources génétiques Ressources génétiques Etude ago-écologique Enquêtes Socio- économie

**Collection 3: Collection of seeds and plants of Thyme and Oregano in the south of Morocco.**

Target species:

- Safran
- Thym sarriette (*T. satureioides*)
- Armoise blanche
- Caprier

Saffron will be collected in the region of Taliouine during the period of bulb production near the end of September. The three other spices will be collected near the end of May 06.

Collection areas:

1. Essaouira, Agadir, Tiznit, Tafraout.
2. Marrakech Taroudant et Ouarzazate.

Collection team: 5 researchers maximum including Dr. Ahmed Amri, ICARDA.

**Budget:**

Expenses	Unit Price	Total
Gasoline		5,000
Perdiem ( 7 researchers x 5 days)	300	10,500
Hotel ( 7 researchers x 4 nights)	300	8,400
Total		23,900

Team I		
<i>Thymus satureioides</i> (Agadir, Tafraout) <i>Thymus broussonetii</i> (Essaouira)	Alfaiz C. H. Ouabbou Amri Hilali N. Saïdi Thami Alami	Ressources génétiques Ressources génétiques Identification Ressources génétiques Enquêtes Socio-économie
Team II	M. Lage Boughlala	
<i>Artemisia spp.</i> (Marrakech, Agadir, Taroudant) <i>Safran</i> (Taliouine) <i>Caprier</i> (Ouarzazate)		Identification Ressources génétiques Etude ago-écologique Enquêtes Socio-économie Etude ago-écologique

**Deliverables:**

1. Seeds, bulbs, and plants.
  - A. Seeds will be maintained at the National Genebank of Morocco for conservation.
  - B. A working sample of seeds, bulbs and plants will be maintained at the INRA/Rabat facility for evaluation and regeneration purposes.
2. Information on the collected germplasm and the collection sites will be maintained in the databases at INRA/Settat and INRA/Rabat.

**3) Production and Processing Activities**

This component will focus on identifying medicinal species with future economic conversion and sustainability can best be guaranteed by cultivation or management *in-situ*. This will require the identification of potential collaborating rural communities and knowledge of micro-climatic conditions, existing food and cash crops and compatibility. It is expected that the team will include agronomists (dryland experts and those specializing in irrigation) and farmers knowledgeable of local agricultural practices.

**Specific activities include:**

Rainfed or rangeland species

- potential species suitable for cultivation;
- ecological and agronomic requirements in the wild (soil, pH, light, moisture, etc);
- adaptation of plants to cultivated conditions;
- characterization of germination requirements and/or potential difficulties (examples);
- tolerance to intra- and inter-specific competition;
- resistance or vulnerability to insect pests and plant pathogens;
- potential harvesting problems;
- requirements of storage to best maintain biological and therapeutic activity;
- ease of processing;
- description of community and farmers interest in participating in the project;
- amount of land communities/farmers can be available;
- possible yield to be expected; and
- recommend best placed communities, species and requirements for sustainable cultivation
- development of sustainable harvesting methods;
- enforcement of sustainable harvesting methods by local people.

**The team will prepare a budget for field activities, equipment, data analysis and report writing including:**

- days expected in the field
- number of field personnel
- salaries and per diems (accommodation, meals)
- field transportation costs
- capital equipment and expendables
- chain of production costs: planting, managing, harvesting, specimen drying, processing, extracting, packaging, storing and marketing
- data analysis and report writing (days)

**4) Required Instruments for Chemical Analysis**

The following list of information has been separated into two categories, the first of which includes equipment and supplies that can be easily obtained and/or are already in-house. The second category focuses on those items that may be in-house but are likely not available or not functioning in their present form. It may be preferable not to focus on this second category of equipment until a second phase of funding. This is due to the difficulties that are likely to surface; however, those items in the more easily obtained category should be pursued.

**A. Easily Obtained Equipment and Supplies**

1. Essential oil analysis equipment and supplies (one example of many available). Multiple set-ups are needed.
  - a. Clevenger distillation apparatus
  - b. Condensers
  - c. Heating mantles
  - d. Heating baths or alternates
2. UV/VIS Spectrophotometer
3. Miscellaneous solvents (pentane, hexane, etc.)
4. Standard laboratory equipment

**B. More Difficult to Obtain Equipment and Supplies (in addition to the above category)**

1. High performance liquid chromatograph (HPLC)
  - a. Binary or quaternary pumps
  - b. UV detector
  - c. Solvent degassing method (vacuum degassing, filtration, helium, etc.)
  - d. Autosampler
2. HPLC columns (C-18 and normal phase)
3. HPLC solvents (acetonitrile, methanol, water)
4. HPLC vials and supplies
5. Gas chromatograph (GC)
  - a. Standard gas chromatograph
  - b. FID detector
  - c. Mass spectrometer optional
6. GC gases (helium and hydrogen)
7. GC columns (DB-5, etc.)
8. Calibration standards for all marker compounds

<b>Appendix 4: Contacts</b>	
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