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FINAL REPORT

Training Workshop on Industrial Exploitation of Medicinal and Aromatic Plants in East Africa

at
The Institute of Biodiversity Conservation & Research (IBCR)

November 16 - 21, 1998

Addis Ababa, Ethiopia

December, 1998

BACKGROUND

The recent increase of public and scientific interest in plant derived medicines has many reasons, not to mention alone, the recent success of paclitaxel and artemisinin to fight breast cancer and malaria respectively. The present popularity of herbal medicines is just a reflection of renewed interest of the developed world in alternative medicines, although major segment of the world's population has always relied on plants to meet their health care needs. The situation in the European Union is encouraging with its well recognized and regulated sale of herbal medicines. The increased demand of herbal products in the developed world, besides providing business opportunities to countries endowed with rich flora, will also encourage industrial production, based on scientific investigations of traditional remedies. At this juncture, the need is to nourish the interface between consumer and resource countries by promoting industrial activities on medicinal and aromatic plants in countries rich in biodiversity.

JUSTIFICATION

The East African countries have traditionally been the source of a number of medicinal products. Their rich biodiversity can be utilized to cater their health care needs as well as to the growing needs of medicinal plants in the developed world. The process of value addition to the material through simple industrial steps at point of its origin, will not only deliver the maximum economic benefit, but will also generate employment for the local people. There are numerous efforts at national and international levels to promote the cause of medicinal and aromatic plants, but they lack concerted approach and all the knowledge gathered through these efforts are lying fragmented. ICS-UNIDO initiated the organization of the training workshop on industrial utilization of medicinal and aromatic plants to consolidate and review this information and provide the participants an overview of the global scenario which would help us in promoting growth of phytoindustry in our respective countries.

Based on these facts, Ethiopia was chosen to organize this training workshop. The Institute of Biodiversity Conservation & Research (IBCR), responsible for collecting, conserving and evaluating the genetic resources which serve as sources of food, fiber, medicine etc. was selected to organize this training workshop due to its role in biodiversity conservation over the years. Moreover IBCR is coordinating a Biodiversity Conservation and Sustainable use of Medicinal Plants Project to which this training workshop could have an input. The Essential Oils Research Center (EORC), dealing with R & D activities of Aromatic Plants was also chosen as a collaborator of organizing this workshop.

OBJECTIVES

The general objective of the training workshop was to provide the participating countries in the sub-region with assessed updated information as well as to come up with action-oriented recommendations and proposals on a systematic and integrated approach towards developing medicinal plant-based industry and ensuring sustainable growth of the sub-sector.

The training workshop was organised in a way that it included lectures, visits to laboratories where R & D activities are undertaken and also a one day field trip to aromatic oils distillation unit to visualise how things are being done in this respect.

Specific objectives:

- To provide technical personnel from selected developing countries in East Africa with assessed technical information on the recent developments of the theoretical and practical aspects of quality control and R&D in the industrial utilization of medicinal and aromatic plants.
- To discuss and plan cooperation possibilities, and possible technical assistance for the development of industries based on medicinal and aromatic plants.
- To create a network of institutions from the East African countries dealing with the industrial exploitation of medicinal and aromatic plants.

An effort was made to represent various stakeholders in the subject of interest viz. public research institutions, private sector, and traditional healers association. This wide range of representation provides a good interaction in the subject matter and promotes the sustainable use of the bioresources.

EXPECTED OUTPUTS

The participants will update their knowledge on the technological developments in the field of industrial utilization of medicinal and aromatic plants. Their enlightenment will provide the needed impetus to promote industry based on medicinal and aromatic plants in their respective countries. The assessment of available technologies will open doors for mutual cooperation for industrial utilization of medicinal and aromatic plants. Initiatives can be taken to prepare project proposal to promote industrial utilization of medicinal and aromatic plants in East Africa for submission to donors for funding. A network of institutions from the East African countries dealing with industrial utilization of medicinal and aromatic plants will be established.

ACHIEVEMENTS

First and foremost the various institutions existing within a country and the region, did not have the information on the activities going on medicinal and aromatic plants and thus this forum gave an opportunity to know each other and establish a co-operation among them. The visit to the Natural Products group at the Addis Ababa University, Chemistry department impressed the participants very much on the existence of such already established networking among some African countries. Most of the participants came with volatile oil samples for GC-MS analysis and the laboratory promised to send them back the analysis result. Another visit conducted in the Ethiopian Health and Nutrition Laboratory, specifically at the Drug Research Department was also interesting in terms of the collection of medicinal plants, the small data base on the ethnomedical information of some 600 plants and the scientific research initiated on some medicinal plants for dosage formulation. The third event was the visit to the Essential Oils Research Center, Wondo Genet branch where aromatic oil distillation is being carried out. The participants had the opportunity to see the cultivation field of aromatic plants, processing that is steam distillation of the plants and handling of the products. This obviously laid a

ground for refreshing any knowledge in the area and also facilitated for initiating establishment of a network.

Sharing of experience, ideas, views and concerns in conservation, processing, utilisation and the associated property right, especially of the indigenous knowledge of medicinal and aromatic plants in different levels, was made possible. Based on this, a number of recommendations came out.

Participants were sensitised of the global importance of medicinal plants and thus gave due attention for the proper conservation and sustainable use of the potential resources.

Major constraints in the area of conservation, cultivation, standardisation, processing, property right, and technology transfer were identified for which corresponding recommendations were proposed.

RECOMMENDATIONS

1 Cultivation

1.1 Constraints

- People are ignorant of the potential of growing medicinal and aromatic plants of significance.
- Industry does not support the cultivation of plants as long as it's obtaining from the wild sources
- Agrotechnology is not easily accessible
- There is a big gap between the industry, research institutes and farmers (potential producers)
- Not all the medicinal plants are amenable to cultivation
- In some countries, government policies, land policies are not conducive to undertake cultivation.
- In the absence of herbal industry, the market potential for medicinal plants is lacking.

1.2 Proposed Recommendation

- National, International agencies & NGOs should take initiatives to make public aware of producing some high value medicinal plants.
- Some incentives should be given to the industry to undertaking cultivation including out growers scheme.
- National agencies should strengthen and promote research in the area of agrotechnological development.
- We should put in efforts to strengthen linkage between industry-research-producers
- Small scale industries need to be promoted to ensure market for the produce.

2 Conservation

- Conservation should be understood as a sustainable utilization of bioresources. However, for comparison purposes of the ecosystem as a whole. For monitoring the changes in the biodiversity there is a definite need to have protected areas as well.

- Medicinal plant conservation should be included in the National biodiversity conservation strategy.
- Incentives should be given to the local community to conserve their biodiversity with emphasis to medicinal plants.
- Government should take the main initiative in the biodiversity conservation and should divert back the earning from such activities to the communities engaged in the biodiversity conservation.
- Introduce an award scheme to acknowledge the conservation activities.
- Strengthen the linkage among the relevant stakeholders to promote conservation activities.
- Policy makers should be made aware of ground realities and should provide alternatives (such as energy, land use) to activities which are detrimental to the environment.
- Public awareness campaign should be undertaken to appraise the people of the benefit of biodiversity conservation.
- The ethnomedical documentation for each country should be undertaken and species under threat should get priority for conservation.
- The facilities available at the regional level (Center for mapping and remote sensing) should be utilized for ecomapping and monitoring of the biodiversity.

3 Utilization

- Ethnomedical information should be utilized to make best use of existing resources.
- There should be close correlation between the research Institutions and the industry to promote the utilization of medicinal and aromatic plants.
- Value addition through simple processes like sorting, drying, etc. should be undertaken at the country of origin. Due publicity should be given to organic farming.
- There is a need to undertake standardization of herbal medicine for keeping pace with the international trends.
- Technical capacity should be built to exploit medicinal plants available in abondant.
- There should be a network of institutes working in the area of medicinal and aromatic plants to promote their utilization.

4. Intellectual Property right (IPR)

- The provision of IPR on traditional knowledge should be made known to the owners of the knowledge.
- Each country should prepare inventory of traditional healers.
- Laws should be inacted to recognize the traditional knowledge.

IMMEDIATE FOLLOW-UP

- ICS-UNIDO shall take the initiative to coordinate the establishment of networking.
- National workshops on exploitation of medicinal and aromatic plants at national level should be conducted and then be extended to the regional level.
- ICS-UNIDO shall make a follow-up of resolutions made during the training workshops.
- Proceedings of such training workshops should be made available to the participating institutions.

13/10/98
KV/GLO/EF/esr

INTERNATIONAL CENTRE FOR SCIENCE AND HIGH TECHNOLOGY

in collaboration with the

Institute of Biodiversity Conservation & Research

and the

Essential Oils Research Center
Addis Ababa, Ethiopia

AIDE-MEMOIRE

Training Workshop on Industrial Exploitation of Medicinal and Aromatic Plants in East Africa

Addis Ababa, Ethiopia
16-21 November 1998

INTERNATIONAL CENTRE FOR SCIENCE AND HIGH TECHNOLOGY

Area Science Park, Padriciano, 99 - Building L2, 34012 Trieste, Italy
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BACKGROUND

The recent increase of public and scientific interest in plant derived medicines has many reasons, not to mention alone, the recent success of paclitaxel and artemisinin to fight breast cancer and malaria respectively. The present popularity of herbal medicines is just a reflection of renewed interest of the developed world in alternative medicines, although major segment of the world's population has always relied on plants to meet their health care needs. A number of plant products are among the top nutritional supplements sold in the USA. This is despite total lack of federal support for herbal products. The situation in the European Union is more encouraging with its well recognized and regulated sale of herbal medicines. The increased demand of herbal products in the developed world, besides providing business opportunities to countries endowed with rich flora, will also encourage industrial production, based on scientific investigations of traditional remedies. At this juncture, the need is to nourish the interface between consumer and resource countries by promoting industrial activities on medicinal and aromatic plants in countries rich in biodiversity.

JUSTIFICATION

The East African countries have traditionally been the source of a number of medicinal products. Their rich biodiversity can be utilized to cater to the needs of medicinal plants in the developed world. The process of value addition to the material through simple industrial steps at point of its origin, will not only deliver the maximum economic benefit, but will also generate employment for the local people. There are numerous efforts at national and international levels to promote the cause of medicinal and aromatic plants, but they lack concerted approach and all the knowledge gathered through these efforts is lying fragmented. ICS-UNIDO intends to consolidate and review this information on industrial utilization of medicinal and aromatic plants at this workshop. This will provide the participants an overview of the global scenario and will help them in promoting growth of phytoindustry in their respective countries.

OBJECTIVES

- To provide technical personnel from selected developing countries in East Africa with assessed technical information on the recent developments of the theoretical and practical aspects of quality control and R&D in the industrial utilization of medicinal and aromatic plants.
- To discuss and plan cooperation possibilities, and possible technical assistance for the development of industries based on medicinal and aromatic plants.
- To create a network of institutions from the East African countries dealing with the industrial exploitation of medicinal and aromatic plants.

EXPECTED OUTPUTS

The participants will update their knowledge on the technological developments in the field of industrial utilization of medicinal and aromatic plants. Their enlightenment will provide the needed impetus to promote industry based on medicinal and aromatic plants in their respective countries. The assessment of available technologies will open doors for mutual cooperations for industrial utilization of medicinal and aromatic plants. A project proposal to promote industrial intiatives in East Africa will be elaborated for submitting to donors for funding. A network of

institutions from the East African countries dealing with industrial utilization of medicinal and aromatic plants will be established.

STRUCTURE OF THE WORKSHOP

The structure of the Workshop includes: lectures, demonstrations and exercises by specialists and seminars on the following topics:

- Herbal medicines- the global scenario;
- Advances in industrial technologies for utilization of medicinal plants;
- Bottlenecks for developing phytoindustry;
- Agrotechnologies and sustainable utilization of medicinal plants;
- Medicinal plants in East African countries;
- Research status on medicinal plants in East African countries;
- Scope of regional and interregional cooperation for industrial utilization of medicinal and aromatic plants;
- Safety, efficacy and quality of phytomedicines;
- Demonstrations of practical techniques used in phytoindustry.

The case studies already developed for the Region will be discussed in seminars.

PARTICIPATION

The Training Workshop is directed to scientists and technologists, who are working in East African countries dealing with industrial exploitation of medicinal and Aromatic Plants. A maximum of 10 participants will be admitted to the Training Workshop coming from Kenya, Uganda, Tanzania, Somalia and Sudan. About 4/5 experts will be invited to lecture on specific topics.

ICS-UNIDO will, in co-operation with the course coordinator, select the participants from the applications received, giving due regard to professional qualifications, experience and other relevant considerations. The course coordinator will select the candidates from the host country.

Each participant will present his/her country status report on medicinal plant based industry at a session reserved for this and it should be elaborative enough to give the panoramic view of the industrial and research status of medicinal plants in his/her own country. A set of one hard and a soft copy (preferably in word) of this report should be submitted to the course coordinator at the beginning of the Training Workshop.

Participants will attend the whole activity according to the schedule prepared by the host authorities and comply with the rules and regulations laid down for their Training.

LANGUAGE

The Training Workshop will be conducted in English and no translation facilities will be available. It is expected that the participants have a good command of English.

TIME AND VENUE

The Workshop will be held at the Conference Hall of the Institute of Biodiversity Conservation & Research, Addis Ababa. Foreign participants will be staying at the Ararat Hotel, Tel: 251 1 611755, Fax: 251 1 613759 Addis Ababa.

FINANCIAL ADMINISTRATIVE ARRANGEMENTS FOR UNIDO-ICS FINANCED PARTICIPANTS

For those who will be invited by UNIDO-ICS to participate in the Training Workshop, round-trip air-economy transportation from the airport of departure will be arranged and prepaid tickets issued where necessary.

A daily allowance to cover board and lodging will be provided upon arrival to Addis Ababa. Reservation will be made for all participants at the Ararat Hotel.

The participants will be required to bear the following costs:

All expenses in their home country incidental to travel abroad, including expenditures for passport, visa, and any other miscellaneous items. UNIDO-ICS will not assume responsibility for any of the following costs, which may be incurred by the participant while attending the meeting:

(1) compensation for salary or related allowances during the period of the workshop;
(2) any costs incurred with respect to insurance, medical bills and hospitalization fees;
(3) compensation in the event of death, disability or illness;
(4) loss or damage to personal property of participants while attending the workshop.

VISA ARRANGEMENTS

Participants are requested to arrange for their visa as early as possible at the Ethiopian Embassy in their home country. In case of difficulties, please advise the contact person mentioned below.

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For additional information, please contact:

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PROGRAMME

Monday, November 16, 1998

9:00-9:30 Registration

9:30-9:40 Opening Address, **Dr. Abebe Demissie**, A/Director General Biodiversity Institute

9:40-9:55 Keynote Address. **His Excellency** Ato Biruk Debebe, V/Minister, Ministry of Trade and Industry

9:55-10:30 Coffee break

Session 1

Chair Person: **Dr. Samson Kibende**
Rapporteur: **Getachew Addis**

10:30-11:10 Introduction to ICS - UNIDO activities and over-view of herbal medicine by Dr Karan Vasisht

11:10-11:20 Discussion

11:20-12:20 Plenary paper 1 by Prof. Dr. Gotz Harnischfeger

12:20-12:30 Discussion

12:30-14:00 Lunch break (Lunch will be served in Gedera Hotel No.3)

Session II

2:00-2:45 Plenary paper 2 by Dr. Ermias Dagne

2:45-2:55 Discussion

2:55-3:40 Plenary paper 3 by Prof Gotz Harniscfeger

3:40 – 3:55 Discussion

3:55-4:30 Coffee break

4:30-5:15 Plenary paper 4 by Prof. Gotz Harniscfeger

5:15-5:30 Discussion

Tuesday, November 17, 1998

SESSION III
Chair person: **Ms Camille De Stoop**
Rapporteur: **Mulugeta Chane**

8:30-9:15 Plenary paper 5 by Dr Nat Quansah

9:15-9:25 Discussion

9:25-9:50 Case Study 1 by Dr. Samson Kibende (Uganda)

9:50-10:15 Case Study 2 by Dr. Grace Nambatya (Uganda)

10:15-10:35 Case Study 3 by Mr. Kimani Mattew (Kenya)

10:35-10:50 Discussion

10:50-11:20 Coffee break

11:20-12:05 Plenary paper 6 by Dr.Ermias Dagne

12:05-12:15 Discussion

12:15-12:35 General Discussion

12:35 - 2:00 Lunch break (lunch will be served in Gedera Hotel No.3)

SESSION IV

2:00-2:45 Plenary paper 7 by Prof. Gotz Harnischfeger

2:45-2:55 DISCUSSION

2:55-3:15 Case Study 4 by Dr. Tadele Worku (Ethiopia)

3:15-3:35 Case study 5 by Getachew Addis (Ethiopia)

3:35-3:45 Discussion

3:45-4:10 Coffee break

4:10-4:55 Plenary paper 8 by Dr. Nat Quansah

4:55-5:05 Discussion

5:05-5:35 Case study 6 by Spencer Muthoka (Kenya)

5:35-5:45 Discussion

WEDNESDAY, NOVEMBER 18, 1998

8:30-12:15 VISIT TO THE NATURAL PRODUCTS GROUP AND LABORATORY EXPERIMENT

12:15- 1:30 LUNCH AT GEDERA HOTEL

1:35 TRAVEL TO WONDOGENET, 265 KM SOUTH OF ADDIS ABABA

THURSDAY, NOVEMBER 19, 1998

8:30-12:15 VISIT TO THE ESSENTIAL OILS DISTILLATION UNITS

2:00-8:30 TRAVEL TO ADDIS ABABA

FRIDAY, NOVEMBER 20, 1998

Chair person: **Mr. Ariaya Hymete**
Rapporteur **Belay Dechassa**

8:30-9:15 Plenary paper 9 by Dr. Nat Quansah

9:15-9:25 Discussion

9:25 - 10:10 Plenary paper 10 by Dr. Ermias Dagne

10:10-10:25 Discussion

10:25-10:45 Coffee break

10:45-11:05 Case Study 7 (Tanzania)

11:05-11:25 Case Study 8 (Tanzania)

11:25-11:35 Discussion

11:35-11:55 Case Study 9 (Sudan)

11:55-12:15 Case Study 10 (Sudan)

12:15-12:30 Discussion

12:35-2:00 **Lunch break**

2:00-2:45 Standardisation of Herbal Medicine by Dr. Karan Vasisht

2:45-3:00 Discussion

OPEN DISCUSSION

Chair Person: Dr. Karan Vasisht
Rapporteurs: Dr. Medhin Zewdu & Dr. Tadele Worku

3:00-4:00 Open discussion

4:00-4:10 Coffee break

4:10-5:30 Visit to the Ethiopian Health & Nutrition Research Institute, Drug Research Department Laboratories

SATURDAY, Nov 21, 1998

Chair Person: Dr. Karan Vasisht
Rapporteurs: Dr. Medhin Zewdu & Dr. Tadele Worku

8:30-10:30 Open discussion continues

10:30-10:50 Coffee break

10:50-11:50 Report of the common recommendation & Discussion

11:50-12:15 Closing remark by H.E. Asrat Bulbula, Commissioner, Ethiopian Science & Technology Commission

12:15-2:00 Lunch

Afternoon : Free time

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* Could not attend the workshop due to some unforeseen problems.

FINANCIAL REPORT

Foreign participants Air tickets	7,313.66
Accommodation and lodging	4,774
Per diem	1,152
Local Participants	1,160
Fee for speakers	1,350
Transportation	903.56
Laboratory Experiment fee	1,000.00
Utilities	1,031.45
Miscellaneous	5,315.33
Total	24,000.00

Annex 1 List of Plenary papers presented at the workshop

Prof. Dr. Gotz Harnischfeger

1. Aspects of assessment and evaluation of indigenous plants and plant products for their use in rational, conventional phytomedicine
   - ethnomedical/ethnobotanical evaluation techniques
   - aspects of quality, safety, efficacy

2. Quality aspects of phytomedicine
   - quality of starting materials (herbs): requirements and implications
3. Basic manufacturing processes of phytomedicines: control and validation procedures
   - GMP in the manufacture of plant preparations

Dr. Nat Quansah

1. Towards sustainable utilization of medicinal and aromatic plants by industry
2. Industry must cultivate the medicinal and aromatic plants that it uses to ensure sustainable utilization
3. To arrive at sustainable of medicinal and aromatic plants by industry requires forging viable and workable partnerships

Dr. Ermias Dagne

1. Chemical profile of essential oils from the African Flora
2. Results of investigations of medicinal plants sold in markets
3. Aloes of Africa: Chemistry, conservation and rational utilization

Prof. Dr. S.S. Handa(*)

1. Bottlenecks in Plant Based Drug Industry
2. Industrial Utilization of Medicinal Plants
3. Standardization and quality control of Medicinal Plants and their products

Prof. Tuley De Silva(*)

1. Industrial utilisation of Medicinal and Aromatic Plants in developing countries:Prospects & Constraints
2. Production of quality herbal drugs
3. Value added products from aromatic plants

* Hand out of the lectures was provided to the trainees.

ANNEX II

Minutes of the training workshop on Industrial Exploitation of Medicinal and Aromatic Plants in East Africa.

Monday, November 16, 1998

Chair person: Dr Samson Kibende

Rapporteur: Getachew Addis,

On behalf of the Organising committee, Dr. Medhin Zewdu has welcomed the guests and participants of the workshop. She invited Dr. Abebe Demissie, A/Director general of Biodiversity Conservation and Research Institute and His Excellency Ato Biruk Debebe, V/Minister, Ministry of Trade and Industry to deliver Opening and Keynote Addresses respectively.

ICS - UNIDO activities: Presented by Dr. Karan Vashist

The presenter explained the objective of ICS as to :- Foster and facilitate the transfer of technology (specific high tech. areas) to developing countries. To accomplish its objective, the Center has an applied information system, which encompasses;

Chemistry particularly on catalysis and sustainable chemistry, biodegradable plastics as well as combinational chemistry and technologies.

- Environment particularly on decision on environmental issues, coastal zone management as
- well as medicinal and aromatic plants.
- Industrial utilisation of medicinal and aromatic plants: promoting sustainable growth of
- industry which is based on medicinal plants in developing countries, providing support, creating network, developing and working on demand based projects.
- Technology services which aimed at technology management, business alliances as well as
- technology and competitiveness.

He has also shown the structure of ICS-UNIDO and indicated its interest to have a network with institutions, which are interested to cooperate with the center. In his presentation, he has given

particular attention to herbal medicines.

Overview of Herbal Medicines

He provided other terms that are used to indicate herbal medicines as:

- Herbal medicines/Herbal remedies
- Plant medicines/Plant remedies
- Phytotherapeutics/Phytopharmacea
- Phytomedicines and Nutraceuticals

In the presentation, he explained that there is an increasing awareness to herbal medicines all over the world because people believe that herbal medicine is less toxic than the synthetic medicine. This has also increased demand of herbal medicines. Different aspects of medicinal plants were explained as follows:

Role of Medicinal plants

Traditional therapies/ remedies

Phytomedicines

Modern medicines

Aromatic plants (perfume)

Present status

In Asia: India, China and Japan are giving much attention

In Europe: Phytomedicines are given an important place in treatment of different health problems

North America: Herbal foods and nutritional supplements are given but Doctors do not have enough knowledge for the practice

Herbal market

It is expanding rapidly. For example, it costs 6.5 billion in Europe and 4.6 billion in Asia.

Strategies to promote utilisation of medicinal plants

Documentation of ethnic knowledge

Based on the traditional knowledge, Promoting scientific knowledge

Developing standards for herbal medicines (authenticity)

Emphasis on safety

Message for national agencies:

Encourage public awareness and provide sound basis for the use of herbal remedies

Monitor wild harvesting and promote cultivation

Encourage value addition at point of origin through simple procedures such as extraction of oils, drying, packing and then exporting to get more profit.

Message for scientific community:

Strengthen the role of folk medicine in modern drug discovery

Protect the right of Intellectual Property Right

These important issues were raised during his presentation and the following questions were raised and answer given by the presenter.

Q. Does ICS provide fellowships?

A. Only ongoing activities can be seen in the institute.

Q. Do you provide funds?

A. ICS does not provide funds. It is interested to draft project documents and submit to funding agencies.

The sources of the knowledge for traditional medicine are developing countries. What do you do for them?

A. ICS is interested to find out those countries who have the traditional knowledge and advise them how to utilise it properly.

Aspects of assessment and evaluation of indigenous plants and plant products for their use in rational, conventional phytomedicine: Presented by Prof. Gotz Harnischfeger, Resource Person

He has commenced his presentation by emphasising the concept to develop medicinal plants in Europe. He explained modern medicine as rational medicine, which is relying mostly on drugs of synthetic origin. Plants became the targets in search of new and more effective drug. In this respect, Ethnobotany is the basis for research and development of drugs of plant origin.

In his presentation, he explained the legal definition of phytomedicine in Europe, which is different from the other countries.

Regular medicines according to the standard legal requirements

Non-conventional medicine

Medicines of alternative therapeutical systems

Nutraceutical, food additives

Therapeuticals of more than dubious value

Regular medicines but with special status. In this legislation, utilisation of plants is legally accepted as a medicine.

The approach in herbal-based drug development is:

Collection of ethnomedical information: Basic information on traditional medicinal value of plants must be collected.

Pharmacological information/Biological assay: The stages for the ethnopharmacological studies were presented

Chemical isolates including clinical studies. The more we know and work following these approaches, the more will be the probability of success.

He has also recommended the following points for herbal-based drug development,

Define the medicinal purpose of the drug (Therapeutical information)

Technological requirements for herbal based drug development

Quality of the starting material

As well as the grading stages for efficacy and safety, collection of literature documents and safety evaluations for drug development were discussed.

Conditions that have to be fulfilled by pharmaceutical industries were also discussed. The main ones are Quality, Efficacy and Safety of the herbal remedies.

He has refereed to WHO for the definition of phytomedicine as finished and labelled products in crude or pure plant preparations. Herbal medical products contain excipient in addition to the active compounds. They may also contain natural organic or inorganic components that is not of plant origin. This indicates that we are dealing with too many chemical compounds.

He has also stressed the importance of monographs. Those monographs should include:
Nomenclature which includes English and French vernacular names as well as its Latin name.
Definition: whole drug reduced drug, powder etc.
Characters: organoleptic, odor and taste.
Identification: macroscopic, microscopic, TLC, chemical reaction.
Test: starch, ash, microbial contamination, etc.
Assay: VIS./UV. Spect., GC, TLC. Etc. He emphasised to use the easiest method.
Storage and labelling.

Stability studies on the active ingredients were also given especial emphasis which has focused on temperature and relative air humidity for the different climatic conditions and the microbial count for finished products should be studied and compared with pharmacopoeia of different countries.

The most important aspect in development of herbal based drugs, quality of phytomedicine, was also discussed as follows: The starting materials for all phytomedicines are plants and the quality of the starting material should be maintained. According to WHO figures, about 21, 000 plant species are listed as being medicinally used and most of them are collected from the wild. Only 50 - 100 plant species are said to be cultivated. The rest of medicinal plants are collected from the wild. The reasons behind collection of plants from the wild were:
The plant species grows slowly.
The plant may not be amenable to agriculture.
In-culturing may pose difficulty.
Collecting is more economical than in-culturing
The tonnage needed for phytomedicine is unimportant.
The dangers in collecting practices are:
Over harvesting
Reduction and /elimination of the local population which results to genetic
variability and
Unnecessary destruction of plants during harvest.

Guidelines for collection of plant material were also described as follows. The collector:

Should be able to identify the plant.

Should be able to distinguish the medicinal plant species from the other relatives.

Should know optimum conditions for the optimum harvest.

Should have personal hygiene.

Should be monitored by competent personnel.

It is indicated above that 50 - 100 medicinal plant species are cultivated. The reasons behind cultivation are the following.

When too few of the plants grow wild.

When the wild source is sparsely distributed.

When the wild plants are inaccessible.

When there is a need to improve yield and quality.

When there is government control.

When only a desired species or variety is used.

It can allow better and quicker post-harvest treatment.

The guidelines of good agricultural practice were also elaborated in detail. It starts from the identification of the plant and includes the measures that have to be taken during cultivation as well as harvesting, drying, packaging and storage, transport, the requirements of equipment, personal as well as documentation.

With regard to the breeding of medicinal plants, the objective should be to increase the quality and yield. It was stressed that economical analysis should be carried out in order to indicate the cost benefit analysis.

Specific analytical aspects of collected plant drugs were stressed as identity; admixture and foreign matter of plant material and the steps to select for analyte compounds as well as properties of the selected analytical methods were also elaborated.

At the end of his presentation the following questions were raised and appropriate answers provided.

Q. What is your comment on Intellectual Property Right?

A. Intellectual property rights for the traditional healers, community or country (Source of the knowledge) should be clearly worked out.

Q. In European pharmacopoeia, there is a restriction in number of microbial count in finished products. What is your comment for other countries?

A. For *E. coli* and *Salmonella*, the count should be zero. But it is practically impossible particularly for *Salmonella.* Regulatory agencies should not be very super-perfect. They should stay on practical level.

Q. As long as the bacteria is harmless, what is the point of restricting the number?

A. European authorities design the upper limit. This can be changed according to the prevailing situations in other countries.

Q. African countries lack sophisticated laboratory equipment. What is your comment on this?

A. Collaboration with universities.

Q. If a synthetic compound is added into a plant material, can we call this a phytomedicine?

A. It can not be considered as herbal medicine.

Q. Suppose a plant is difficult to cultivate and with extremely very important and little percentage of the bioactive compound, what is your comment on this kind of plant?

A. Find an alternative plant species for the same purpose.

Marketed medicinal plants of Ethiopia: Presented by Dr. Ermias Dagne, Resource person

He has presented the medicinal plant market in Uganda and Ethiopia. His presentation focused on selected Ethiopian medicinal plant species.

Kebericho:

This species is endemic to Ethiopia and is identified as *Echinops kebericho*

The smoke of the plant is traditionally used by the people.

Chemical analysis was carried out and dehydrocostus lactone is found to be the major compound.

The smoke contains dehydrocostus lactone, which is experimentally found to be cytotoxic. This indicates the effect of fumigation of kebericho.

Dingetegna:

It is an endemic plant.

In Ethiopia, it is chewed to relief pain.

It is identified as *Tavernera abyssinica*

It is biologically tested and found to inhibit smooth muscle contraction.

Nine compounds were identified and none of them were found to be active but the work is still underway.

He has also explained the survey on medicinal plant market in Ethiopia as follows.

The survey has included 19 markets in the central regions of Ethiopia and 416 vendors were investigated. The first sold medicinal plant was *Hagenia abyssinica*. 241 vendors sold this medicinal plant which is known to contain kosotoxin. This species grows in Eastern African high lands. In one of the James Bruce's book, another medicinal plant, Waginos (*Brucea antidysentrica*) was also indicated.

He has also mentioned about the stimulant plant, *Catha edulis*, which is well known in Ethiopia and other East African countries, *Phytolaca dodecandra*, which is a soap substitute, and other medicinal plant species such as *Croton machrostachys* and *Vernonia amygdalina*.

After his presentation the following questions were raised and answers provided.

Q. What do you know about the toxicity of hydrocortisone lactone?

A. The active compound is toxic. Therefore, the dosage should be carefully worked out.

Q. Kosso is used as medicine against flat worms by creating muscular contraction. Does it have effect on roundworms?

A. Evidences (as in case of Germany) indicates that it was used as antiascaries.

Q. Studies were carried out on chemistry of medicinal plants. What about clinical studies?

A. This part of the study is encouraged.

Date: 17-11-98
Chairperson: Ms Camille De Stoop
Rapporteur: Mulugeta Chane

To Wards Sustainable Utilisation of Medicinal and Aromatic Plant Industry
By Dr. Nat Quansah, Resource Person

Dr. Quansah pointed out that industry must have the supply and availability of raw materials required so that the industrial utilisation of medicinal and aromatic plant becomes sustainable. In the utilisation of such plant the local people will be benefited directly or indirectly through cultivation and processing activities.

Industrial utilisation of medicinal and aromatic plant lead to the over harvesting (over exploitation) of resources and often leading to the extinction of these plants especially if the industry is dependant on the wild sources, he added.

The speaker emphasised that in order to avoid such over exploitation (over harvesting) of the plant from the wild, we must help nature to continue to help us by ensuring the existence of such plant. The industry should invest in research and development and actively enter into cultivation of those medicinal and aromatic plant that can be cultivated and work with local people.

We use plant in their crude and refined forms as phytomedicine, health food, cosmetics, herbal teas and intermediate for producing new drugs, because they are the base material for drug preparation as well. We are over dependent on wild plant, and thus the use of aromatic and medicinal plant have often not been sustainable. E.g. in India industry depends almost 90% and in Madagascar 80% collection from the wild. The same is true for most of the other countries that the majority of medicinal plants used by industry come from wild collection, the presenter explained.

More over, over exploitation is caused due to inappropriate method of harvesting e.g. bark ringing, cutting down the whole tree to take the leaves and up rooting the whole roots or underground reproductive organs. These and other related reasons lead to the unsustainable utilisation of the plants.

Insufficient knowledge on the plant itself, required plant part, possible level of exploitation, harvesting techniques, optimum growth, yield determination, pick production time of the plant, economic life time, decline period of the product of the plant, the types of the root system, leads to over exploitation, and further the extinction of the species, he described.

The speaker pointed out the problems of sustainability; he also proposed some of the solution to be taken by industries towards using medicinal and aromatic plant in a sustainable way.
Industry should invest on research and development of medicinal and aromatic plant,
undertake inventories, germination studies, regeneration and growth and habitat requirements, yield determination in order to have cultivation of the required plant species

The majority of the plants are monoculture. Therefore, there is a need to diversify the plant

population, and alternatives should be sought.

Agroforestry and inter cropping system should be promoted.
There should be a partnership with all stakeholders, such as outgrower's scheme with local people who are involved in maintaining natural habitat of the species.

Cultivation can be carried out by enriching the population by introducing planting materials, seeds (seedlings) of the species in question with in its localities

If the plant species is difficult to cultivate, or takes longer time to be economical, look into alternatives, that is search for similar plants that can easily be cultivated and does the same purpose

Appropriate law and legislation should be put in place that encourages industry to participate in conservation and cultivation.

Questions and comments raised during discussion were the following:-

Q. Do you have experience on a kind of agriculture with in a natural environment?
A. In India Gum Arabic, being produced in an industrial scale, Acacia Senegal is growing in agro forestry system. But they still depend on the natural collecting with in the same area.

Q. Is there a subsistence income from growing medicinal plant or not the competition between other commodities like charcoal, crop etc?

A. Some of the activities are under ground business, the charcoal men may not know about biodiversity and sustainability, he may not be interested about conservation. So there is a need to make the people aware of the sustainable use of the plant (forest).

There is an alternate to utilise the marginal area and keep the environment balanced rather than competing with farm land allotted for field crop cultivation. And use the afforestation program by including medicinal plant through inter-cropping.

Q. Did you come across about the compatibility of the crop and medicinal plants to be inter cropped in terms of the effect on nutrition, moisture, sunlight, disease and pest?

A. One has to know about the plant to plant relationship, their growth pattern, life time of the plant (annual, perennial etc.) and their feeding habit in order to know their compatibility.

Q. What is your suggestion that the local people tend to use medicinal plants from conserved (protected areas) because the protected area is protected from local people while it is open for tourism?

A. It is from the policy angle that the land use policy should make the people comfortable, the local people should have an access for the resources from the protected area with motivation and make aware the people so that, they can use the resources sustainable. The level of protection should

be enough to motivate local people to see the resource and to take care while using.

The Merging of Traditional and Western Medicine Drug Trials of Herbal Mixtures on HIV/AIDS Patients. Joint Clinical Research Center, Kampala, Uganda
Dr. Samson Kibende

Dr. Kibende explained that, Exploitation of our medicinal plant is still pre-industrial and research and development is still in its infancy stage in this region of East Africa. We are facing various problems including how to use the traditional people. The cost of experiment of the traditional medicine for HIV epidemics is about 8000 dollar per test. There is a big challenge to integrate the two system, the western and the traditional practitioners. The challenge has been and still is to standardise and harmonise this type of treatment using tools of modern science. This calls for extensive research to establish efficacy and safety of these mixtures besides their preparation and preservation.

Dr. Kibende explained that, screening of traditional herbal practitioners is the first work before doing any work together, in order to screen the traditional herbal practitioners who claims for everything, to find out the genuine to work with them by asking questions about what they know. But sometimes the genuine one do not come to the center they stay in the villages. Selection of the traditional healers who keep records on what they have done, in order to make a crosscheck and follow up is done.

Some traditional healers are showing up with mixtures of medicinal plants, which they are not willing to tell about what the mixtures are. At the same time the identification of the mixture during clinical trials is very difficult, Dr. Kibende said.

A kind of tool used to evaluate an ordinary herbal mixture, brought by traditional health practitioners for its safety and efficacy, are standard modern facilities. Safe herbal mixtures have been tested for efficacy at the joint clinical research center on a number of HIV positive subjects, he added.

Questions, comments raised are as follows:-

Q Have you not used animal model while you are studying the toxicity of the mixture of 8 medicinal plant?

A. There is no need to use animal model for toxicity, because the traditional people have used the medicines in the past by them selves.

Q Is there any clearance form like the western medicine?

A. Yes there is an ethical committee, which look into the proposal for the efficacy and safety

Q. What is the opinion of the community, how frequent to visit them?

A. We do not have much to manage them but there is a letter recognised by the herbal practitioners that would be approved by the community leader to observe their opinion.

Q. Do you under take the test individually for a particular plant, rather than 8 plant mixture together?

A. This test will be made at the later stage only for the sake of efficacy and safety

There was a common question addressed by all the participants about whether efficacy and safety test are important or not for the medicinal plants which are being used by the people, and the discussion was:

No need to test its safety and efficacy because it is effective and safe and has been used by the people since long time, but there is a question of acceptability, affordability and accessibility. Even though effectiveness and toxicity is proved for several plants by several generation for the sake of check up there is a need to under take efficacy and safety tests.

The Medicinal Plant Based Industry in Uganda- a Status Report
Dr. Grace Nambatya, Uganda

By way of introduction, Dr. Nambatya, mentioned that traditional health systems has a big role in addressing the health care needs of developing countries. The traditional health care system should be included as a matter of policy in the planning, processing and in the national and international budgeting for health care provision. This could be done in conservation of the plant with the traditional medical practitioners and their representative organisation.

The traditional knowledge should be promoted by new investment in appropriate designed research, in the training capacity, integrating system of modern and traditional health practitioners and sustainable use of medicinal plants, she added.

Traditional systems of health care have undergone a major process of revival in the past decade. Policy interest in traditional approaches to health care has led to this revival. The common reasons for the new interest are: economic factor, cultural factor and national crises (war, and national epidemics). Revival of traditions in different parts of the world, often following decolonisation or increased self determination for indigenous groups, has led to some countries (Uganda is an example) to re-evaluate and promote their traditional medical systems, she discussed.

Dr. Nambatya, discussed about the Natural Chime Therapeutics Research Laboratory in Kampala (CRL) which was established in 1985 to test claims of efficacy and safety of herbal remedies used in Uganda. The laboratory operates under three main sections: botany, chemistry and pharmacology.

Research activities of the center have a strong linkage to Traditional Healer Co-operation, which is organised in small groups with their leaders and communicate through the leaders. The National Traditional Association is not yet established.

In 1986 when the National Resistance Movement (NRM) came in to power, a Health Policy Review Commission was put in place. Recommendations by the commission to Government include the following Dr. Nambatya said.

The ministry of health should work closely with traditional healers in order to achieve the objectives Ministry of Health should arrange training program for traditional healers.
Traditional Healers should be encouraged to form a national association, which should act as the nucleus through which the Ministry of Health could regulate and supervise their practices.
Referral of patients between medical practitioner and traditional healers should be open and acceptable

Land should be made available to grow medicinal plants identified by traditional healers and funds should be made available to preserve these identified plant species.

Status of CRL

Ethno botanical surveys in all district of Uganda, with systematic documentation of reports were done.
A medicinal plant herbarium with 1750 species and 5,000 specimens collected from all over the country.
Advisory service to individuals and traditional healers association through field visits, discussions meetings are being made.
Laboratory chemical analysis of plant for their medical values is already underway.
On going collaborative research with other government institution, NGO's e.g. THETA, and International Agencies to conserve medicinal plants in the country are being done.

Status of Medicinal Plants Based Industry

The few industries involved in the manufacturing of medicinal plant based drugs are all in the private sector and on very small scale. Main example is SALOMPAS BULLI's Agency, which is mainly involved in collection of medicinal plant from different regions of the country, preparation of water crude extract and packing for sales, Dr. Nambatya said.

The Speaker Suggested needs to be advanced for Medicinal Plant Based Industries.

Availing of more science research funds through the Uganda National Council of Science and Technology (UNCST) is vital; part of which would be put to strengthen herbal research.
Encourage herbal culture in young western-trained medical personnel, so that prejudice between western and traditional ways of treating the population is reduced.
Establishing of proper distribution centers for the well formulated medicinal plant product is essential.
Availing fund for initiating new medicinal plant based industries is important.

Industrial Exploitation of Medicinal and Aromatic Plants in East Africa
The Kenyan Experience
By Michael M. Kimani

Mr. Kimani started his presentation by listing down industries that are involved in their raw material production.

Pyrethrum Board of Kenya: Although this organisation in buying and selling of all pyrethrum grown in the country, it collaborates with small-scale farmers who cultivate the crop. Kenya is the world's biggest producer of pyrethrum flower.

British American Tobacco Ltd: This company contracts tobacco agricultural inputs, supervise the farmers to ensure that they grow tobacco, they also grow enough trees for the curing process. It has also been involved in the development of more efficient tobacco curing kilns.

Kenya Planters Co-operative Union: This is a farmer's union that oversees coffee production: It provides agricultural inputs to the farmers on credit terms. In turn, the farmers deliver their coffee to the union for processing and sale.

East African Tanning Extraction Company: The company owns vast amounts of land, where it grows black wattle trees for their vegetable tannin production from the bark.

Medicinal and Aromatic Oil Industry in Kenya

In the last 3 years, a small-scale perfume-making unit has come up in Mombassa. This factory uses flowers as a source of perfume aroma. It produces for both local and export markets, he discussed.

For medicinal trials, there is a unit in the Kenya Medical Research Institute (KEMRI) that is supposed to look into traditional herbal medicines, and subject them to modern scientific analysis. Although herbal medicine is available quite readily in the country, the activities of this unit are not widely known, the speaker said.

In Limuru, a private herbal clinic has started operations. It goes by the name of KAMIRITHN HERBAL CLINIC.

The presenter said, amongst the kikuyu people, a creeping plant known as "mubuthi" is used to "strengthen bones" or faster healing, if they are broken. The leaves of this plant are boiled with meat and the ensuring bitter broth is drunk. The bitter extract is also said to prevent nausea as a result of excessive fatty meat consumption.

Castor oil was commonly used to treat open wounds. The oil mixed with the powder obtained from a small yellowish-gray fungus known as "dogamuuki" for faster healing.

Amongst the Kiswahili people of Kenya, the "Mrubaini" plant is reputed to treat a wide variety of diseases. The active ingredient is obtained by boiling the leaves, the roots or both of them: fever,

headaches and hypertension are just sore of the disorders it is reputedly able to relief.
The speaker also said that on the streets of many towns in Kenya, one would come across announcing:
Doctor of Botanical Medicines
Doctor of Traditional Medicines
Herbalist

All these refer to traditional herbal treatments for various ailment. These traditional herbalists are however registered with the Ministry of Culture and Social Services, and not with the Ministry of health. In the past, they have operated as other ordinary shopkeepers. Many of these herbalists also double up as:
Fortune tellers
Wizards and soceeron.

Chemical Profile of Different Aloe Species from the African Flora.
Dr. Ermias Dagne
Chemistry Department of Addis Ababa University

Dr. Ermias explained about various phytochemical isolation and characterisation of individual substances from plant material of aloe. The research activities mainly focused on extraction, isolation of component and structural elucidation. Dr. Ermias have shown slides of the different types of aloe species which where identified and collected from South Africa, Eritrea and Ethiopia.

Aloe vera is a cosmopolitan's plant and cultivated as a medicine in America. Most of the aloe species are concentrated in South Africa, 75% are endemic. Aloe Verifier is the most common plant in West Africa Dr. Ermias said.

Dr. Ermias also discussed the botanical description and taxonomic investigation of species, family and genera of aloe using chemotaxonomic methods that lead to the identification of the given plant. He also mentioned the key compound of aloe species Barberton aloe, which have an application for skin protection as a cream.

Aloe derivatives were also found in one of South African Aloe species, which were isolated from the exudate. The isolations work was done and the results were published, he added.

Dr. Ermias also discussed Kniphofia species, which have been grown in the highlands of Ethiopia. The chemistry of the plant and isolation of the compound were done and named according to their content.

Questions and answer session

Q. During the drying process of aloe exudate it turned to light yellow, what could happen to the compound during the process? Is the color change due to some chemical change?

A. The reply was, the studies did not indicate whether there is a change in the composition or not.

Q. Are you investigating your medicinal plant extract or isolate to treat HIV?

A. So far no test has been done but there is a request from EHNRI and as a chemist it is possible to extract and investigate it in the future.

Aspects of Phytomedicine Quality. Prof. Gotz Harnischfeger (Resource Person)

The presenter explained that phyto-medicine should be made at industrial levels. Since extracts from plant part are composed of various foreign materials, the quality should be maintained, be standardised, and economically viable to produce. When it reaches to the consumer it should be clearly labelled to indicate the content of the medicine. The difference between herbal drug and modern drug is that synthetic drugs contain fixed and identified dosage level whereas we quote ranges of constitutes in herbal drug which shall be effective. Standardisation of Phytomedicine is possible and done by setting ranges to which the relevant components comply. The range has to be declared on the label and should contain:
The mass of native extract
The range of native plant drug / extract ratio
The amount of starting material
Information about type and concentration of the solvent

Extraction

As the presenter explained that there are a number of extraction technologies of which maceration, digestion, agitation and percolation are the ones used in processing of herbal medicine. Modern techniques have not changed much for the last 200 years. However certain things makes extraction quicker such as putting the drug in to the basket and the material is absorbed or leached by the solvent and exhaust the raw material, he added.

What types of process controlling are needed for factories?

The choice of polarity, the effect of solvent on the components of the plant drug being dissolved.
Temperature during extraction, which influence the solubility.
Particle size of the drug Vs. time of extraction. The particle size of the drug modifies the accessibility and duration of establishing equilibrium.

Concentration and Drying of Extract

The presenter explained about isolation of the extract, this could be done by evaporation under reduced pressure lowering the temperature for the solvent using the rotary vapour in order to separate the product and the solvent.

Formulation
The speaker mentioned some points during formulation of plant products

What is the plant used for
The technological requirement for processing
The requirement of the raw materials

The speaker emphasised that the quantitative aspect of the extractable compounds in plant drugs that is their ratio in the internal composition is variable due to environmental influences such as; climate, soil, time of harvest etc. The bulk material has also an influence on the quality parameters of the preparation, especially when the amount of active ingredients is small compared to the inert bulk material.

The problem in formulation of solid phytomedicine is the prevention of transition solid to liquid i.e. prevention of water uptake from the surrounding atmosphere and separation of reactive components in the final formulation. Most dry extract plant products are exposed for affinity towards moisture, it takes up the moisture from the air humidity and undergoes agglomeration, and as a result the final product becomes semi-liquid solid product. To avoid such problems the speaker recommended working in dry environment.

Chemical process may occur primarily in the liquid phase and influences the entire composition of the herbal medicine. These are inter-conversion, hydrolysis, condensation and polymerisation. The presence of heavy metal, enzymes and the influence of light and oxygen are inducing to such process.

Physical and chemical interactions with and among the bulk material of neutral co-extractives are frequent and causes for instabilities manifesting turbidity and flocculation. To prevent physical degradation especially precipitation and flocculation, the following precaution should be introduced in to the manufacturing processes, he said.
Minimisation of extraction of neutral bulk materials
Removal of oxygen
Treatment, if possible through cooling.

Final product

What would happen with the final product in the storage? The type of components in the extract should be known to avoid any adulteration in its quality. If the extract is acidic, one might have to control the pH. And some products like tannins through self-condensation reaction process tend to settle in to the bottom as the presenter said. Some plant products under go metabolic, microbial photochemical reaction, etc., example, essential oils. Therefore, it is important to know category of compounds in the extract so that their handling could be managed appropriately.

Validation

Not only laboratory procedures are validated, but the manufacturing procedure must also be known for the customer. Not every step should be validated but very critical steps in the procedure have to be controlled and it is maintained at all times in order to look in to the

following:-
micro biological contamination
identification of suitable measuring parameters
selection of monitoring methods
selection of target criteria indicating validation
implementation of validation plan
collection of data
review and critical assessment

The whole steps should be documented and the guideline for manufacturing process should be considered as law, and a format for such documentation was presented.

personnel
the quality control
contract manufacture
self inspection
proper documentation

Industrial utilisation of medicinal and aromatic plants in Ethiopia
Essential Oils Research Centre, Dr. Tadele Worku

The presenters, Dr. Tadele in his introduction noted that the people of Ethiopia in the course of their long history learned much about the therapeutic quality of the country's flora even though this great natural resources has not been yet utilised in the production of therapeutics.

As in other part of the world, the Ethiopian people resort to the use of medicines to relieve symptom and cure disease. Among several traditional health practices in Ethiopia, practice with the use of herbs is the major one. More over, many authors have written that most of the population in Ethiopia relies on traditional medicine, he added.

The speaker also remarked that, Ethiopia is rich in flora, and being located along the equator, a wide variation in altitudes makes it possible to introduce plant not indigenous to the country.

In spite of the abundant and varied flora in Ethiopia, processing of the derived chemicals from this flora into intermediate product is not practised due to lack of appropriate technology transfer, he explained.

The Essential Oil Research Centre is a governmental institution engaged in Research and Development and pilot production of essential oils and other plant material. The centre has acquired about 80 ha. of irrigable land at Wound Genet with a French type of plant distiller with a capacity of about 1-2 ton /day of biomas. It has also a moderately equipped laboratory, which is built and assisted by foreign donors such as Swedish Agency for Research Co-operation with Developing Countries (SAREC/ SIDA). It is also equipped with adequate agricultural machinery, tools, offices buildings, water and power supply and necessary man power (agronomist, chemist laboratory technicians and field worker), the presenter informed. The Research Centre's

objectives as the Presenter pointed out are:

Promote research and development activities on traditional medicine, herbal remedies used by traditional practitioners
Evaluate traditional medicine in the light of modern science, to maximise useful and effective practices and discourage the harmful
Promote, stimulate, organise and direct multidisciplinary research on aromatic chemical and traditional medicine in the country.
Contribute significantly to the development of the agro- industry in product diversification in earning and saving of foreign country.

The Activities of the Research Centre Mainly Focus On

Collection and selection of chemical bearing plants mainly medicinal and aromatic plant at present more than 200 plant species of various types are collected.
Agronomic studies on the collected plant species
Identification of various ecology in the country where medicinal and aromatic plant could be cultivated currently four agro-ecology were identified.
Extraction and characterisation of plant product for their content and chemical composition have been carried out
Production of essential oils on pilot scale for demonstration and market. Currently three types of essential oil (lemon grass, citriodora and palmarosa) are being produced for commercial purposes and being marketed for local soap and cosmetic industries.

Technical assistance and co-operation requirement.

Research and development activities in the field of medicinal and aromatic plants in general are at its infant stage. Very limited expert are working on essential oils, on the other hand interest has been observed to develop essential oils product in the country, these could necessitate technical assistance in training, technology transfer, laboratory equipment and pilot scale units so that good result could be attained, he explained.

Constraint to the Development of Industry

As the presenter indicated, some of the constraints of aromatic and medicinal plant cultivation and processing were: -

The awareness in the field is far from satisfactory
The number of authenticated and botanically described medicinal and aromatic plant are limited
Laboratory facilities for quality specification are not adequate
Trained manpower and know how in the field is limited

Questions and Answer session

Q. In some parts of the world, they are using essential oil for HIV blood stream, did you test this?

A. For a sauna and inhalation some people are using Eucalyptus globulus. As aromatherapy for HIV it is not yet started

Q. What is the cost of essential oils per a kilo?

A. It is around 9 dollars for lemongrass oil.

Research and Development on medicinal plants in Ethiopia
Ethiopian Nutritional and Health Research Institute (ENHRI)
Getachew Hadis

The speaker pointed out that research and development activities on medicinal plant in Ethiopia were introduced several years ago to search for medicine. There are two approaches used to develop a medicine: -
Classical (molecular)
Alternative approach

The classical (molecular) approach is time consuming and there is a probability of no medicine after exhausted work have been made which could cost about 15-20 million dollars.

Using the alternative approach, which is cost and time effective and based on the major health problem of the country, the Institute is working in this line. Using this approach it is possible to promote the traditional medicinal plant by up grading and standardising the existing knowledge and technology, he said.

There are criteria to select a medicinal plant to be introduced for research and development activities in order to search medicine, the speaker said.

Is there literature available elsewhere?
Is it used as a source of food, medicine? is it commonly used for both traditionally and in the modern medicine?
Health problem priority such as malaria?
How much does it take for study?

Achievement

well developed man power but there is a brain drain, and thus the researcher should be supported by incentives to keep them in the area
collection of ethnomedical information even though it is transferred orally from generation to generation

Utilisation

Safety, efficacy and pharmacological study are being done in order to standardise chemical dosage formulation. This would require the collaboration of many stakeholders, who acquire the facilities.

Documentation

Selection and translating Geez information in to Amaharic and English, establish different data base of ethnobtanic information

Future Activities

conservation of plant resources
study how to multiply the plant
characterisation of the product
utilisation study
agro ecological investigation
encourage farmers to grow medicinal plant together with food crops.

Industry Must Cultivate the Medicinal and Aromatic Plans That It Ensure Sustainable Utilisation.
Dr. Nat Quansah (Resource Person)

Cultivation

Industry must cultivate medicinal and aromatic plant to ensure utilisation sustainable, Industry must encourage farmers and partner ship, invest for cultivation and encourage every body to cultivate the same species to get competition for the supply of consistent quality materials, Dr. Nat said.

Cultivation of the material should have:-
desirable quality
more control over production
more consistency in quality
lower risk for adulteration

Cultivate where?

Dr. Nat explained that cultivation should be done within the locality where the species is naturally found because unique agro-ecological and biological requirement of the species demand specific climate. Moreover, there are reductions in cost, risk for pest and disease, and other related factors.
Cultivate with other crops of locally grown, because species never grow by it own, it grows at

a community level. Cultivate medicinal plants with agro forestry system.

Cultivate when the market is assured in order to minimise the risks. Industry benefits from the plant and the knowledge of local communities on plants and the locality maximise its benefit out of the resources by maintaining the ecosystem.

How to Start

Select the plant and ensure with the identification. Some are variety specific and some are genus and family specific.
Carry out inventory of the wild species; see in to the habitat.
Research on the plant to know which part of the plant is used for propagation: the leaves for some seculant plants, seeds, roots, etc.
Research on the optimum requirements of the plants: temperature, water, soil, etc.
Research on the duration required by the plant to germinate, mature flowering and fruiting period, natural regeneration process, the pollination agent
Carry out yield studies (how much material be required with in specific period of time (economic life time), harvesting period, when it is the best time, harvesting techniques, does it need special techniques? what is the tolerable limit not to damage the base materials.

When to Start Cultivation?

according to the objectives (the criteria for cultivation)
the quantity for the purpose
the demand and supply
just see the substitute

The Influence of (IPR) on the Commercial Exploitation of Medicinal Plant in Africa
Spencer M. Muthoka
Principal Research Officer; Kenya Industrial Property Office.

In Africa, herbalism is an indispensable cultural heritage that bridges the gap between the availability and demand for essential drugs, M. Muthoka said.

M. Muthoka explained about the major problems experienced in handling herbal drugs in Africa including lack of efficient preparation techniques, storage, method of formulation, lack of access to raw material, depletion of medicinal plants through various agencies, **secrecy and issues of ownership** of indigenous herbal knowledge.

The presenter emphasised on the twin problems, secrecy and ownership, touched up on issues related to intellectual property rights (IPRs) and are easily recognisable as the most significant obstacles to meaningful exploitation of medicinal plants in the various countries. He also emphasised that the great majority of traditional healers are mostly unaware of the significance and even the existence of legislation on IPR.

Issues relating to ownership of herbal medicine

Traditional Practitioners

Most traditional medicine practitioners in Africa operate under tight secrecy. The source of their medicine is normally a closely guarded secret as are the methods of preparation and treatment. Most of the time they come up with a mixture of different plants, which are difficult to know what the mixture is. Because there is a constant fear by the healers that disclosing their knowledge would lead to loss of exclusive ownership and adversely affect the level of income earned from the practice. So with out formal protection of one's invention, any other person with access to the information can utilise it without reference or compensation to the owner.

Infringement will not have occurred in the absence of proof of any specific intellectual property rights. It is indeed risky to rely solely on secrecy for the protection of one's invention simply because it is not fool proof. Any mixture or formulation can be analysed in a laboratory and the contents can be determined. Findings from such analyses are patentable and according to the law, the first who claims for registering the innovation becomes the owner of the granted rights.

Indigenous Right

Communities every where in the world have developed knowledge and found ways to derive their livelihood from the bounties of nature diversity. The issue of ownership of indigenous knowledge is of current debate and has been on the spotlight since the introduction of the convention on biological diversity at Rio Dejanero in 1992. There is concern that indigenous knowledge is being exploited with out due compensation to communities. As the speaker said, it is a normal practice for foreigners to come to communities in Africa, gather from them very useful information on their herbal medicinal practices and put that information to commercial purposes.

TRIPS Agreement

The present trend in the use of medicinal plant as a source of raw material for the manufacture of drugs internationally calls for different approaches to the issue of ownership of herbal drugs. This approach should include an in built mechanism that would ensure the ownership of the knowledge and material is not disclosed to multinationals with out due and appropriate compensation to local communities. It is for this reason that the issue of intellectual property right must be considered and taken seriously if commercial exploitation of medicinal plants is to be meaningful to our people, M. Muthoka said.

Intellectual Property Right in Africa and the Existing Structure

Industrial Property Laws

Most of the countries in Africa have laws providing for the protection of invention although the modalities of protection vary considerably from country to country.

Regional intellectual property organisations

Two regional IPR organisations are currently operational in Africa
- African Regional Industrial Property Organisation (ARIPO)
- African Intellectual Property Organisation (OAPI)

The presenter explained about the major advantage of these two regional IPR organisations. The potential applicants can file for protection of their invention simultaneously in more than one country by submitting only one application. It makes it easier for an applicant to have the assurance of broad protection in Africa by filing through only one country or either of the two regional IPR bodies.

Constraints in Application of IPR in Herbal Medicine

The detailed composition or content of most herbal medicine used in Africa is Unknown.

The traditional medical practices rely heavily on oral indigenous knowledge that has been handed over through generations. In most places this knowledge is getting lost as the elder generation die out with out passing on the knowledge. There is therefore, a need to record this information. The best record would have been contained in IPR document but no such records have been kept in Africa.

Commercialisation is a strong aspect of IPR but lack of capital may become a hindrance to full exploitation of granted right.

Questions and answer session:

Comment. There is a problem of property right not only addressed as individual right but it is also a country property right. TRIPS Agreement should include an in built mechanisms that would ensure the ownership of the source materials that should not be lost to multinationals with out due and appropriate compensation to local practitioners. It is for this reason that the issue of intellectual property right must be considered and taken seriously, if commercial exploitation of medicinal plants is to be meaningful to our people.

M. Muthoka said that the issue of ownership of indigenous knowledge is of current debate and has been on the spotlight since the introduction of the convention on biological diversity at Rio dejanerio in 1992. There is concern that indigenous knowledge is being exploited with out due compensation to communities.

Q. Why is the patent at the molecular level, rather easy to patent the composition as a whole, even patent the raw materials?

A. The claim for patent is on the quantity of the entire composition. Any concoction or formulation can be analysed in a laboratory and the contents determined. Findings from such analyses are patentable and according to the law the first to file becomes the owner of the granted rights.

Q. How do the traditional healers come up with their patent for their product (discovery), since the process of patenting is very expensive?

A. Two regional IPR organisations are currently operational in Africa (ARIPO and OAPI) which help for the potential applicants. The applicants can file their invention for protection simultaneously in more than one country by submitting only one application. It make it easier for an applicant to have the assurance of broad protection in Africa by filing through only one country in one of the two regional IPR bodies.

DATE : 20-11-98
CHAIRPERSON : Mr. Ariaya Hymete
RAPPORTEUR : Mr. Belay Dechassa

Sustainable utilisation of Medicinal and Aromatic plants requires forgoing viable and workable partnership, by Dr. Nat Quansah

Dr. N.Quansah explained that sustainable utilisation of medicinal and aromatic plants by industries requires a viable and workable partnership between companies, local communities and states. He further elaborated what a viable and workable partnership is.

According to him it is a contractual relationship between parties on a mutual business venture. It has to be with clear and attainably objectives. There should be mutual trust, honesty, responsibility and respect between parties.

He also explained that the contracting parties should work together as good teams with a goal to sustainable utilise medicinal and aromatic plants.

As to who should be in the partnership Dr. N.Quansah explained that individuals, local communities living in the areas where the medicinal and aromatic plants are found, the state, companies and concerned institutions must come together and talk about how to sustainable use medicinal and aromatic plants.

He concluded his explanation by stressing that a viable and workable relationship be forged among concerned users of medicinal and aromatic plants in order to ensure continuous availability of medicinal and aromatic plant for industry and help alleviate poverty of communities where these plants occur.

Questions and comments were raised by the participants of the workshop on the need of exchange of information and communication between different professionals (Chemists, Pharmacologists, Botanists etc.) to give awareness for people (community) in the work of health care to work with a common goal.

Participants of the workshop also stressed that partnership is required between different countries and organisations to work for a common goal with clear objective.

Gas Chromatographic Profile Of Essential Oils Of Flora From Africa, By Dr. Ermias Dagne,

According to briefing done by Dr. E. Dagne Essential oils which are obtained by steam distillation of aromatic plants are important activities of research program of chemistry department of Addis Ababa University.

Essential oils of local species such as ginger, garlic, Korarima (Aframomum korarima) etc. and essential oils from several species originating from different parts of Africa were analysed.

Dr. E. Dagne further confirmed that chemistry department of Addis Ababa University is well equipped with up-to-date analysis equipments such as GC, GC-MS and NMR. They have also generated data on several essential oils bearing plants and results are compiled in a database: - Gas chromatographic profile of essential oils from African Flora". As typical examples, chromatographic profile of essential oils of Artemisia abysinica Artemisia afra jacq, Artemisia rehan, Ociumum lamifolium, Lippea adoensis, Cymbopogon sp. Basil from Comoros, Basil from Zimbabwe were shown and their oil yields and composition of different chemical constituents in the oils were discussed.

Dr. E. Dange therefore hoped that such a work would lay a good scientific basis for a wider use of these resources.

He further stressed those medicinal and aromatic plants that are used in abundance in local and export markets should be thoroughly studied and continually monitored for composition of their constituents.

STATUS OF MEDICINAL PLANTS IN TANZANIA.
by Dr. Zakaraia Mbwambo

Dr. Z. Mbwambo has his presentation on the subject as follows: "The institute of Traditional Medicine research has been established to do multidisciplinary research aimed at enhancing the contribution of traditional medicine in the delivery of health care in Tanzania.

The institute conducts field data studies with traditional healers, documents and stores ethnobiomedical information and materials pertaining to all aspect of traditional medicine. Additionally, the Institute is working towards development of an ethnobiographic and disease atlas in the efforts to bring closer traditional and western health care delivery systems for the benefit of the country at large.

In parallel a floristic list of all plant species has been prepared and the specimen are stored in the institutes of herbarium.

Regarding the utilisation of medicinal and aromatic plants: - In 1983 a UNIDO-funded project entitled "Assistance for production of plant derived pharmaceuticals" with the objectives of

developing industry to produce plant derived pharmaceuticals and to develop indigenous capability in research was commissioned.
In the course of implementation of the said project a pilot extraction plant was erected and experimental cultivation of 35 medicinal and aromatic plant species selected from international pharmacopoeia, was carried out in four different stations with in the country. However due to a number of reasons the implementation of this project could not reach the intended goal.

Conservation status of Tanzanian Plants:

The moist forests of Tanzania, particularly those on the mountains and East Coast, are exceptionally rich in endemic plant species.

However they are threatened by man's activity for use of timber, fuel and construction poles etc. Medicinal plants like any other plants of biodiversity are also threatened. To conserve the ecosystem and individual species, Tanzania has adopted two simultaneous strategies, e.g. the conservation on maximum plant biodiversity, and focused approach aimed at individual plant species. In an endeavor to conserve individual species of medicinal and aromatic plants, the Institute of Traditional medicine has established experimental medicinal and aromatic plant farms in several parts of the country.

Presentation by Dr. Cosam C. Joseph
University of Dar Es Salam,Chemistry Department, Tanzania.

Dr. C. Joseph has presented research work results done on antimalarial, antibacterial and antifungal agent and drug for sleeping sickness from Tanzanian plans. The choices of plants were based on Ethno-botanical and chemotaxonomical information. The work includes antimalarial activity data of crude extracts and pure compounds from medicinal plant investigated. Studies at the chemistry department of the university also focused on plant species used in traditional medicines for infectious diseases namely bacterial and fungal. About 150 plants species were screened and some of these, which showed activity, were analysed for their chemical constituents and their active principles were established.

Recently, about 48 plant species from different families have been investigated for trypanocidal activity for the search of drugs for sleeping sickness.

Presentation by Sayadat El-Tigani From University of Khartoum Botany Department, Faculty of Science.

According to the presentation of El-Tigani study work on the preliminary biological screening of nine species from Rubaceae families were done. Detection of compounds such as alkaloids, soumarins, flavonoids, saponins and tannins using extraction solvents like petroleum ether, chloroform and methanol were done.

The method of analysis used was thin layer chromatography (TLC); compounds detected using TLC were further confirmed using MS & NMR.

Study Of Some Aroamtic Plants Grown In Sudan.
Dr. Mohammed El Hafiz El Tayeb from University Of Khartoum, Faculty Of Pharmacy, Department of Pharmacology.

According to the presentation of Dr. Hafiz, four aromatic plants namely Cymbopogon citratus, Cymbopogon proximus, Ocimum sanctum and Pulicara undultata were chosen with the objective of finding new source of volatile oils which could be potential raw materials of high value products.

Physicochemical analysis such as moisture content, yield, density, refractive index, ester and acid value determination were done for the above mentioned plants. Also physicochemical analysis of pulicaria herb collected at different months was done and results reported.

STANDARDISATION OF HERBAL MEDICINE.
by DR. KARAN VASISHT

The following important points were mentioned by Dr. K.Vashist on standardisation of Herbal medicines.

There is a global resurgence for standardisation and use of Herbal medicines. Uses of herbal medicines against conventional medicines vary from country to country. For example Germany supports use of herbal medicines more than USA. Global recognition of herbal medicine is increasing and there is greater emphasis on quality standardisation. There is great challenge to know the active ingredients and other inert substances accompanied which effluence biodiversity and excretion of the active components. Internationally there are several pharmacopoeia (official book of standards published by several countries) such as ESCOP, USA, American Herbal Pharmacopoeia, IMMA, Indian pharmacopoeia which provide monographs stating quality parameters and standards of many herbs and some products made out of these herbs.

Standardisation is required to ensure safely, quality and therapeutic efficacy of medicinal products. Required standards for herbal medicines are quality and quantity of active components, additives and synergetic. Intercomponents influencing the GIT environment, stabiliser and synergist have to be determined too.

When adapting standardisation one has to make room for natural variation and procedures specific to herbs.

Cultivation of plant drugs could solve most problems of inconsistency. Wild plants are often heterogeneous due to several factors such as age or harvesting period, method of drying and etc consequently heterogeneous in their content of active components.

The following quality control has to be carried out for medicinal plants.

- Authentication
- Foreign matter determination

- Organoleptic evaluation
- Microscopical examination and other qualitative and quantitative analysis such as: - Volatile matter determinations.
- Polar, medium polar and non-polar solvents extractives determination.

Analysis of pesticide residue, heavy metals, microbial and radioactive contamination are also very important as medicinal plants are liable to be affected by them. Common analysis equipment employed for qualitative and quantitative analysis of plant drugs is thin layer chromatography (TLC) & High-pressure chromatography (HPLC).

Production of standardised herbal drugs requires good manufacturing practice (GMP) with adequate batch analysis and standardised methods. General protocols of standardised plant drug production starting from raw material identification up to finished product handling has been shown in figure & discussed.

Photographs of different plants, which are source of several drugs, were shown by Dr. K.Vashist and discussed regarding their medicinal value.

Dr K.Vashist was asked by one of the participants of the workshop to brief procedures & stages of Indian practices to work on Herbal medicines. His answer to that was as follows:

India's Herbal medicines are well documented by ICMR. There is a centre (Centre for Advanced Research) established by ICMR which carry out the work of formulation, standardisation and maintaining quality of drugs for clinical trials.

= THE END =

ANNEX III

THE MEDICINAL PLANT BASED INDUSTRY IN UGANDA A STATUS REPORT

by
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Indigenous or traditional knowledge of human health and medicine (mainly medicinal plants) currently forms the basis of primary health care for the majority of the World's population. A new role for traditional health systems in addressing the health care needs of developing countries and indigenous communities requires that they be included as a matter of policy in the planning process, and in the national and international budgeting for health care provision. This should be done in consultation with the traditional medical practitioners and their representative organizations.

The new respect that is emerging for traditional health knowledge should be matched by new investments in appropriately designed research, in the development of training capacity to preserve and perpetuate traditional knowledge in the context of an integrated system of modern and traditional health care, and by investments in the sustainable use of medicinal plants

Long relegated to marginal status in Health planning in developing countries, traditional systems of health care have undergone a major process of revival in the past decade or more following a resurgence of interest in traditional systems of health (Bodeker, 1994).

Policy interest in traditional approaches to health care have led to this resurgence Reasons for this new interest :

Economic factors

The majority of the rural population of developing countries have difficulty affording Western Medical health care. Typically, more than 80% of health budgets in developing countries are directed to services that reach approximately 20% of the population. Of this, 30% of the total health budget is spent on the national pharmaceutical bill (Bannerman et al., 1983).

Cultural factors

Cultural factors play a significant role in the continued reliance on traditional medicine. Often villagers will seek symptomatic relief from modem medicine, while turning to traditional medicine for treatment of what may be perceived as the 'true cause of the condition" (Kleinman, 1980). Traditional medical knowledge is typically coded into household cooking practices, home remedies and disease prevention, health maintenance beliefs and routines.

National Crises

In addition to economical and cultural factors, national crises have served to spur governments into evaluating their indigenous medical traditions as a means of providing affordable and available health care for their citizens. Two common influences have been war and national epidemics. Ref (Wars in Uganda)

Epidemics: In Africa, governments facing huge drug bills for the growing AIDS crisis are looking to their indigenous medical traditions and medicinal plants in order to identify inexpensive and effective treatments for at least alleviating the suffering of AID victims.

Revival of traditions in different parts of the world, often following decolonisation or increased self determination for indigenous groups, has led some countries to re-evaluate and promote their traditional medical systems, Uganda is an example in this respect

The Natural Chemotherapeutics Research Laboratory, Kampala

The Natural Chemotherapeutics Research Laboratory (NCRL) was established in 1965, with the mission objectives to test claims of efficacy and safety of natural resources (i.e. plants, animals and natural resources) used in Uganda Traditional Medicine.

One of the factors that could have stimulated research into this area of medicine, was the feeling of political independence.

The NCRL;

The Laboratory is situated about 3kms. from Kampala city center. The Lab. operates under three main sections namely- Botany, Chemistry and Pharmacology. An integrated approach between these disciplines is being adopted due to the need to explore research opportunities. Work to re-equip the lab has been going on since 1993 and is near completion

Research activities at the NCRL

Research activities at the NCRL have a strong linkage to Traditional Healers cooperation and close relationship and trust has gradually developed between the two institutions . Not all has been smooth at the lab., because the lab witnessed its own share of hardship during the period of turmoil in the country.

In 1986, when the N-P-M government came to power, a Health Policy Review Commission was put in place. Among the task they handled, was Traditional Medicine issues in the country. Recommendations by the commission to Government included the following:

1. The Ministry of Health should work closely with Traditional healers in order to achieve all for all by the year 2000. They should be members of the health the objectives of he and should be welcomed to Participate in primary health team at local community level care.

2. Traditional Healers should be encouraged to form a National Association which should act as the nucleus through which the Ministry of Health should regulate and supervise their practice

3. The Ministry of Health should arrange appropriate training programs for Traditional Practitioners such as Traditional Birth Attendants and bone setters.

4. Referral of patients between Medical Practitioners and Traditional Healers should beopen and acceptable.

5. The Natural Chemotherapeutics Research Laboratory should be strengthened to carry out applied research on such aspects as bottling and packaging traditional medicine.

6. Land should be made available to grow medicinal plants by Traditional Healers and funds should be made available to preserve these identified plant species.

Progress at the NCRL

1. To date the NCRL has been involved in the following; Ethnobotanic Surveys in all Districts of Uganda- with systematic documentation of reports **in** 22 out of 39 districts

2. A medicinal plant Herbarium with up to 75 Families (mainly of Flowering/Higher plants), 135 Genera, and 1750 species and 5,000 specimens collect from all over the country

3. Advisory services to individuals and Traditional Healers Associations, through field visits, discussions/meetings.

4. Laboratory chemical analysis of plants for their medicinal values is already underway following the arrival of new laboratory equipment.

5. Local database (card catalogue on local names of plants and their uses, and pharmacological preparations; and the corresponding scientific research results.

6. On-going collaborative research with other government institutions, NGO's e.g. THETA, and International Agencies in the efforts to conserve medicin plants in the country.

7. An ongoing project on biodiversity (conservation of medicinal plants that are becoming scarce).

Future prospects

Plans are under way to enable the NCRL operate under a parastatal Organisation(UNHRO) and therefore be more responsible to direct its research and developmental activities with less beurocracy from the parent ministry of Health.

National Drug Authority, through the NCRL and other institutions is working out strategies for research and development of herbal medicines in Uganda.

The NCRL hopes to further explore prospects for collaborative research, Training and Development of herbal medicines in Uganda. Possible areas include; Herbal medicines quality control, Medicinal plants conservation. Traditional knowledge preservation and Economics sustainability of herbal medicines.

STATUS OF MEDICINAL PLANT BASED INDUSTRY

The few industries involved in manufacturing of medicinal plant based drugs are all in the private sector and on very small scale. Main example is : **SALONPAS BULL'S AGENCIES**

SALONPAS is mainly involved in collection of medicinal plants from different regions of the country, preparation of water crude extracts, which are preserved in a simple way and packed for sale.

Crude as this may sound, this industry is owned by a lay person who within the available financial constraints has endavoured over the years to standardise his crude method of working. This is well indicated by the type of staff he has, i. E. a pharmacist who carries out some phytochemical analysis on old and new herbs that come **in** on regular basis, (This helps them to authenticate the plants in use), Medical doctors (western trained), who carry out diagnosis of disease in their out-patient clinic at their main offices situated in Kampala.

They have a ware house in a Bwaise industrial area, where they do store their dried herbs. They also have gardens where they have cultivated a number of medicinal plants, a factor that helps a lot in reproducibility of results as well as conserving the treasured biodiversity.

After processing of the crude medicine, it is sold out in various outlets in the country, and in addition they do have an established weekly radio programme intended for educating the masses in certain facts about herbal medicine, how to use herbal medicine as first aid, and which medicinal plants are meant for which ailments not to mention those that are poisonous.

However, much as one would take SALONPAS as the leading industry in this sector, it has set backs, e.g., appropriate storage facilities for their dried herbs, a laboratory for analytical work (to

date they use hired space in Makerere University Pharmacology Department Library) packing materials, alternative equipment for modern and more efficient ways of processing their medicine. There is a general lack of accredited laboratories in the country, which implies that conforming to international standards in formulating these herbal drugs is still out of reach by any existing industry or research center in Uganda.

The **Uganda National Bureau of Standards** (UNBS) laboratory was only recently established and just struggling to be accredited by an overseas laboratory (i.e Sweden). However, interests of having an internal accrediting body within the country have been expressed by UNBS, in that there is hope that soon we shall have an equipment calibration centre in the country, and an accrediting body, so that all products like herbal formulations conform to international standards. According to the liberalisation of trade in Uganda, this would go a long way in increasing earned revenue, by selling herbal drugs across borders.

The NCRL, as the main research centre in the field of medicinal plants is trying to undertake the following activities under the new establishment of UNHRO: carrying out of analyses of various formulations (brought in by the public practicing in this field) to check on quality, and ascertain which contents are in there, and in what quantities. The major constraint so far is that of staffing, but this is to be soon overcome

This follows a need to:

- Aascertain whether chemicals are present in the right quantities with approved compatibility.
- Need to combine a particular number of plants, Quality status of herbs used at the time (checking on counts of micro organisms).
- Establish shelf life of a herbal formulation.
- Check on toxicity levels.
- Check on types of preservatives and levels.
- Design appropriate lebels
- Establish proper packaging
- Help traditional medicinal practitioners to fulfill the National Drug Authority requirements for drug registration

THE FOLLOWING NEEDS FOR ADVANCEMENT OF MEDICINAL PLANT BASED INDUSTRIES HAVE BEEN IDENTIFIED

- Availing of more science research funds through the Uganda National Council of Science and Technology (UNCST), part of which would be put to strengthen herbal research.
- Enhancement of herbal research which can be enculcated in the population right from the educational grass root level.
- Encouraging a herbal research culture in our young western trained medical personnel, so that prejudice between western and traditional ways of treating the population is reduced.
- Availing funds for initiating new medicinal plant based industries.
- Establishing of proper distribution centres for the well formulated medicinal plant products.

OTHER BODIES SUPPORTING MEDICINAL PLANT RESEARCH

THETA (Traditional and Modern Health Practitioners Together against Aids). An NGO committed to promoting traditional medicine to compliment modem health care services, and to utilizing. This as health educators and counsellors for Sexually Transmitted Infections (including HIV) and other diseases. This NGO also carries out research about medicinal plants, document and disseminate information about traditional medicine, above all they advocate for traditional medicine (mainly medicinal plants), among health professionals and other scientists.

MAKERERE UNIVERSITY (Department of Chemistry, Botany Department: Science faculty & Faculty of Environment), stand out as examples of sectors where courses at both first degree and Masters degree by course work in medicinal plant research have been established following a resurgence of interest in medicinal plants the world over. This furnishes hope to the future of having a new generation of elites that will appreciate the medicinal nature of plants around us.

The medicinal plant industry in Uganda leaves a lot to be desired, i.e. more funding for those with an interest in research, or putting up more industries.

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THE INFLUENCE OF INDUSTRIAL PROPERTY RIGHTS ON THE COMMERCIAL EXPLOITATION OF MEDICINAL PLANTS IN AFRICA

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INTRODUCTION

In Africa, herbalism is an indispensable cultural heritage that bridges the gap between the availability of and demand for essential drugs. Medicinal plants have been known and used through generations for treatment of various diseases. A number of plant species have been used traditionally as emetics, antihelminthics, purgatives, antibacterials and antivirals. Hunters and gatherers use thousands of plants for food, shelter and medicine. In Africa indigenous knowledge has been the foundation of traditional medical practice since time immemorial. It is a heritage whose contribution to disease control and treatment cannot be overlooked particularly when one recognises that in many places access to modem medical services is minimal.

Techniques used for herbal preparations, storage and administration have varied widely from one community to another and even from one herbalist to another in the same locality. Simple formulations of plant products have been prepared for clinical trials and have been proved to be of potential economic importance in health and agriculture as drugs, pesticides and fungicides. A good example **in** this regard is the *neem* tree, popularly known in Swahili language as "mwarubaini" which literally translates to "curative for forty illnesses".

The major problems experienced in handling herbal drugs in Africa include lack of efficient preparation techniques, storage, methods of formulation, lack of access to raw materials, depletion of medicinal plants through various agencies, secrecy and issues of ownership of indigenous herbal

knowledge. The twin problems of secrecy and ownership touch on issues related to Intellectual Property Rights (IPRS) and are easily recognisable as the most significant obstacles to meaningful exploitation of medicinal plants in the country. It is important to realize that the great majority of traditional medicine men are mostly unaware about the significance of and even the existence of legislature in the country on intellectual property rights. Less still is the knowledge of how IPR may be utilized to protect their creations such as processes, products and formulations.

ISSUES RELATING TO OWNERSHIP OF HERBAL MEDICINE

1. Traditional Practitioners

Most traditional medical practitioners in Africa operate under tight secrecy. The source of their medicines is normally a closely guarded secret as are the methods of preparation and treatment. There is constant fear that disclosure would lead to loss of exclusive ownership and thus adversely affect the level of income earned from the practice. Sometimes even close family members are kept in the dark about the activities of practitioners for fear that they might divulge the secrets outside the family circles.

These fears are real. They are founded on either real life experience or on information obtained from colleagues who may have been unfortunate to lose their innovations to other persons since without formal protection of ones invention, any other person with access to it can utilize it without reference or compensation to the owner. Infringement will not have occurred in the absence of proof of any specific intellectual property rights. It is indeed risky to rely to depend solely on secrecy for the protection of one's invention simply because it is not foolproof. Any mixture, concoction or formulation can be analyzed in a laboratory and the contents determined. Findings from such analyses are patentable and according to the law the first to file becomes the owner of the granted rights.

2. Indigenous Rights

Communities everywhere in the world have developed knowledge and found ways to derive their livelihood from the bounties of nature's diversity. The issue of ownership of indigenous knowledge is of current debate and has been on the spotlight since the introduction of the Convention on Biological Diversity at Rio de Janeiro in 1992. There is concern that indigenous knowledge is being exploited without due compensation to communities. It is a normal practice for foreigners to come communities in Africa, gather from them very useful information on their herbal medicinal practices and put that information to commercial purposes.

A number of questions have been raised as to who owns biodiversity; the mode of just and fair compensation to contributors of knowledge and genetic resources. These questions are central to the debate surrounding the conservation and use of biodiversity and are directly related to the implementation of the Convention.

Throughout history, biodiversity has been the common property of communities-with both resources and knowledge being shared and exchanged freely. However, discussions about the Trade Related Aspects of Intellectual Property Rights (TRIPS) have focused on the assumption that only the intellectual property contributions of corporate-sponsored scientists need protection and compensation. The emergence of genetic engineering has led to grant of patents and other IPRs for products derived from biodiversty. However, this new regime IPRs for biotechnology products is also rewriting the traditional rights in blodiversity. Instead of being treated as the common property of local communities or as the national property of sovereign state, the Third World's biodiversity has in recent years been treated as the common heritage of the world. In contrast, the modified biodiversity is patented and sold back to the Third World as high priced and patented seeds and drugs. The traditional farmers who have selected, improved and conserved blodiversity or the traditional healers who used biodiversity for medicine should also be seen as having prior IPRs which should be protected. Indeed when this knowledge is used and biodiversity is exploited for commercial purposes these contributors should have a say in deciding whether such exploitation should take place and the terms of compensation.

3. TRIPs Agreement

The present trends in the use of medicinal plants as a source of raw materials for the manufacture of drugs internationally calls for a different approach to the issue of ownership of herbal drugs. This approach should include an in-built mechanism that would ensure that ownership of the source materials are not lost to multinationals without due and appropriate compensation to local practitioners. Moreover, since in the liberalized global trade in commodities, governments are required to adhere to the terms of **TRIPs** agreement under which "patents shall be available and patent rights enjoyable without discrimination as to place of invention, the field of technology and whether products are imported or locally produced", IPR laws and policies need to be revisited to ensure that benefits are enjoyed by the owners of the medicines. It is for this reason that the issue of intellectual property rights must be considered and taken seriously if commercial exploitation of medicinal plants is to be meaningful to our people.

INTELLECTUAL PROPERTY RIGHTS IN AFRICA: THE EXISTING STRUCTURES

1. Industrial Property Laws

Most of the countries in Africa have laws providing for the protection of inventions although the modalities of protection vary considerably from country to country. Many of the countries have previously depended entirely on IPR laws of their colonial masters where the practice was for an applicant to first file abroad before the application could qualify for registration locally. For example, former British colonies used to issue certificates of registration for inventions first patented in Britain. The Gambia, Ghana, Seychelles, Sierra Leone, Uganda and Tanzania still do so. This system is cumbersome and rather prohibitive for inventors. Thus a number of these countries are reviewing their laws to have independent industrial property laws. Kenya, for example, enacted her Industrial Property Law in 1989 and can thus process applications directly. She can amend the same law to respond to changing local situations like the need to protect indigenous medical knowledge.

2. Regional Intellectual Property Organizations

Two regional IPR organizations are currently operational in Africa:

- **African Regional Industrial Property Organization (ARIPO)** is based in Harare, Zimbabwe, and brings together 12 mostly Anglophone countries in eastern, central and southern Africa regions. Its objectives include the promotion of harmonization and development of industrial property laws of member states, assist members in the development and acquisition of suitable technology and grant patent and industrial design certificates.

- **African Intellectual Property Organization (OAPI)** is based in Yaounde, Cameroon, and has current membership of 13 mostly Francophone countries in western Africa and the Sahel region. It serves as the "National Office", for all the member states, meaning that the individual member states donot have separate legislature on industrial property rights. Thus a patent registered by OAPI is applicable in all member countries.

- The major advantage of these two regional IPR organizations is that potential applicants can file for protection of their inventions simultaneously in more than one country by submitting only one application. This is quite advantageous considering the logistics and paper work involved in a single application. It makes it easier for an applicant to have the assurance of broad protection in Africa by filing through only one country or either of the two regional IPR bodies.

- **Patent Co-operation Treaty System (PCT)** is based in Geneva, Switzerland, and has a membership of 85 countries (as of April 1996). It is administered by the World Intellectual Property Organization and is yet another system available, through a number of countries in Africa, for applicants to obtain protection in other countries of the world.

CONSTRAINTS IN APPLICATION OF IPR IN HERBAL MEDICINE

The detailed composition or content of most herbal medicines used in Africa is unknown. It therefore becomes difficult to satisfy the stringent requirements for application of IPR such patents where details of the inventive step must be included and specific claims made. There is therefore need for concerted effort to raise the standard of research to the level where the identification of structures of the active molecules is possible. Sometimes purified substances **in** isolation do not carry the potency of the raw concoction. In this case it may become necessary to look into elements of IPR legislation with a view to strengthening aspects that may offer protection with less stringent requirements. Kenya is revising her IPR law to provide for utility model certificates for processes of preparing herbal medicines.

- Traditional medical practice relies heavily on indigenous knowledge that has been handed down through generations. In most places, this knowledge is getting lost as the older generations die out without passing on the knowledge. There is therefore a need to record this information. The best records would have been contained in IPR documents but no such records have been kept in Africa.

- Commercialization is a strong aspect of IPRs but lack of capital may become a hindrance to full exploitation of granted rights. There is need for governments and individuals to explore suitable mechanisms of commercialization such as licensing, joint ventures, equity, etc. There is an urgent need to encourage both the private and public sectors to invest in research and development in this area.

- As a result of the Convention on Biological Diversity, there is increased consciousness on the need to conserve the biodiversity and utilize it sustainably. Medicinal plants are fast disappearing due to over-exploitation, indiscriminate cutting of forests and woodland, environmental degradation and overpopulation. It is absolutely necessary that African governments take urgent measures to curb loss of biodiversity by implementing conservation measures.

BIOLOGICAL AND PHYTOCEMICAL SCREENING OF PLANTS
I. RUBIACEAE

by

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A preliminary biological screening for secondary plants metabolites usually used in folk-medicine was carried out. Nine species belonging to 8 genera from the rubiaceae were screened. Table 1 list the latin names, local name(s) where possible, location, habitat of the species and of collection.

Table (1): Latin name, arabic(s), habiat, site & date of collection and the part used from the selected species of the family rubiaceae.

Latin Name	Vernacular Name(Ar.)	Location	Habiat	Date of Collection	Collect or
Borreria stachydea V a r stachydea(hochst) K.Schum.		Gadarif	Wild on clay soil	Sept. 1992	Babiker, H.A.A
Coffea sp	Bun arabi	Shambat	Planted	Oct. 1992	,,
Galium aparioides (Forssk.)		Erkowit	wild in rock crevices	Feb. 1993	,,
Galium sp.		Erkowit	Wild on rock crevices	feb.1993	,,
Gardenia ternifolia (Schum &Thonn.)	Um Gawy	Khartoum university Campus	Wildy planted	May 1993	,,
Kohautia ternifolia Var. Caespitosa Bremek.)		Erkowit	Wild on sandy Khor beds	Feb. 1993	,,
S a r c o c e p h a l u s latifolus (Sm) bruce	Karmadod a- Umm- Dueima(A r)	Rashad	Wild on rocky water catchmet areas	Nov.1992	,,
Vangueria venosa (sond.)	Shagar - El Karar	Rashad	Wild on clay soils at the edges of Khors	Nov. 1992	,,
Catunaregam nilotica (Stap, Tirvengadum	Shagar - El Marfein Um - Takirni (Ar.)	Rashad	Wild near hilly slopes	Nov. 1992	,,

Preliminary screening for the detection of secondary compounds from the experimental materials of the nine taxa using successive solvent extractions has shown that the petroleum ether extracts lipids and compounds with less polarity, whereas chloroform and methanol extract compounds with increasing polarity therefore, the latter methods were used throughout the analyses.

The results presented on tables 2 and 3 summarize the presence or absence of alkaloids, coumarins, flavonoids, saponins and tannins in the Rubiaceous taxa investigation. The chloroformic and methanolic extracts of the

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Table (2): Detection of secondary compounds in the selected Rubiaceaous species

Species	Part used	Alkaloids	Commarin	Flavonoids	Saponins	Tannins
Barreria stachdea	Stem	0	1	111	01	01
	Leaf	0	11	111	01	111
Coffea sp*	Stem	0	1	1	11	11
	Leaf	0	11	111	111	111
Galium aparinoides	Whole Plant	0	01	111	01	11
Galium sp*	Whole Plant	0	01	111	01	11
Gardenia ternifolia	Steam	0	1	111	111	11
	Leaf	0	1	111	111	11
Kohautia caespitosa var.caespitosa	Steam	0	01	111	1	11
	Leaf	0	111	111	11	11
Sarcocephalus latfolius	Steam	0	1	111	1	11
	Leaf	0	1	111	11	111
Vangueria venosa	Steam	0	11	111	111	11
	Leaf	0	11	111	111	111
Catunaregam nilotica	Steam	0	111	111	111	111
	Leaf	0	11	111	111	111

111 = High amount 01 - Trace
11 = Moderate amount O - Not detected
1 = Present

Table(3): Detection of Secondary compounds in successive extractives of the selected Rubiaceos species

part used	Extraction	Alkaloids	Coumarins	Flavonoids	Saponins	Tannins	Barreria stachydea
Stem	Pet	0	01	01	0	0	Coffea sp.
	Chl	0	11	11	0	0	
	Meth	0	01	111	01	111	
Leaf	Pet	0	01	1	0	0	
	Chl	0	11	11	0	0	
	Meth	0	01	111	01	111	
Stem	Pet	0	0	1	0	0	Galium aparinoides
	Chl	0	0	111	0	11	
	Meth	0	0	111	1111	111	
Leaf	Pet	0	1	1	0	0	
	Chl	0	111	1	0	0	
	Meth	0	1	11	01	111	
Whole plant	Pet	0	01	1	0	0	Galium sp.
	Chl	0	01	1	0	0	
	Meth	0	1	11	01	111	
Whole plant	Pet	0	0	1	0	0	Gardenia ternifolia
	Chl	0	01	111	0	0	
	Meth	0	01	111	111	111	
Stem	Pet	0	0	1	0	0	Kahautia caespitosa var caespitosa
	Chl	0	0	111	0	0	
	Meth	0	1	111	111	111	
Stem	Pet	0	0	1	0	0	Sarcocephalus latifolius
	Chl	0	11	11	0	0	
Leaf	Meth	0	01	111	01	111	
	Pet	0	0	1	0	0	
	Chl	0	11	11	0	1	
	Meth	0	01	111	01	111	
Stem	Pet	0	0	01	0	0	Vangueria venosa
	Chl	0	0	1	0	1	
	Meth	0	11	111	111	111	
Stem	Pet	0	0	1	0	0	Cahina regamnilotic
	Chl	0	0	11	0	11	
	Meth	0	11	111	111	111	

Leaf	Pet	0	1	01	0	0	a
	Chl	0	11	11	0	11	
	Meth	0	11	11	1	111	
Steam	Pet	0	01	1	0	0	
	Chl	0	1	11	0	111	
	Meth	0	1	111	111	111	
Stem	Pet	0	0	1	0	0	
	Chl	0	0	11	0	11	
	Meth	0	1	111	111	111	
Leaf	Pet	0	01	1	0	0	
	Chl	0	1	11	0	11	
	Meth	0	1	111	111	111	

111 = High amount 01 = Trace Pet = Petrolium ether
11 = Moderate amount 0 = Not detected Chl = Chloroform
1 = Present Meth. = Methanol

Stems of the nine species were separated chromatographically using the solvent system benzene: ethyl acetate (86:14,v/v) and 10% potassium hydroxide as a detecting reagent. Ultra -violet light (336nm) revealed the presence of a common fluorescent spot at Rf value of 0. 16 (figure 1) . The chromatographic properties of this compounds were similar to those of the coumarins authentic standards given on table but with a different Rf value (figure I a). The further identification of this coumarin is under study.

Saponins of the selected Rubiaceous species were separated by TLC for comparison. For solvent systems were used: n-Butanol:acetic acid: water (4:2:1,v/v), chloroform: methanol: water (65:45:10,v/v) and (60:35:5,v/v) (65:35:10, v/v) lower layer.

For the more detailed photochemical study, the crude saponins from *C. nilotica* stem and leaves were extracted according to the method described previously. The saponin contents obtained from stems and leaves were 35% and 2.46% respectively. Accordingly the stems were used for further analysis.

Figure 1b shows the separation pattern of crude saponins from the stems and leaves. A major difference detected between the two types of tissues is two compounds having Rf values 0.26 and 0.1 detected in stems. On the other hand, the leaf crude saponins contained five major compounds with Rf values: 0.45,0.37,0.26,0.12 and 0.03. Therefore , there are qualitative and quantitative differences in the crude saponins of the two organs of *C nilotica*

Acid hydrolysis of total saponins from *Cnilotica* stem

Since the percentage of crude saponins from stems in *C.nilotica* was higher than that of the leaves, the stems were used in the acid hydrolysis. The total sapogenins obtained from 2-g of total stem saponins was 1.295g. These were chromatographically separated using 3 solvent systems: Benzene:

ethyl acetate, (86:14,v/v); benzene: methanol, (9:1,v/v); benzene: ethyl acetate, (6:2,v/v). Spots of authentic compounds were loaded on the same plate with the unknown extracts for comparison.

The results presented in figure 2 indicate the presence of three compounds: one major corresponding to oleanolic acid, the second minor, corresponding to sarsapogenin and a third unidentified compound. Further, confirmation of these results was achieved by MS and NMR analysis of the isolated sapogenins.

Isolation of sapogenins of *C.nilotica* stems by PTLC

Preparative TLC was used for the isolation of *C.nilotica* genins using the solvent system benzene: ethyl acetate (86:14,v/v). Three bands were loaded namely aglycones (I,(II) and (III). Each was removed from the chromatoplate and eluted with chloroform and crystallized from hot methanol. Each crystalline residue was identified as follows:

Sapogenins (1). Sapogenin (1) was crystallized from hot methanol as white needles (41mg) m.p.310^{0}C, identified as oleanolic acid from MS(456), identified as oleanolic acid from MS (456,) and confirmed by Co-chromatography with authentic compounds and m.p. The MS spectrum showed the fragmentation pattern of oleanolic acid. The assignment of NMR spectrum of compound (I) is presented on table(4).

Sapogenin (II). Chromatographic separation of aglycone II revealed a single spot in the three solvent systems (figure 1). It was crystallized from hot methanol as white needles (9mg) m.p. 194-195^{0}C, identified as sarsapgenin from TLC with authentic sarsapogenin in two different solvent systems: Benzene: ethyl acetate (86:14,v/v) and benzene: methanol (9:1,v/v). Identification was confirmed by MS (416) and NMR spectra.

Sapogenin (III). TLC separation of aglycone III revealed a single spot in the different solvent systems (figure 2) and this compounds did not correspond to any of the available authentic genins. It was crystallized from hot methanol as white crystalline needles (8mg). This genin is under further investigation.

Identification of the sugars

The acidic aqueous solution left after extracting genins was neutralized with ammonia and evaporated to dryness. The residue was dissolved in 10% isopropanol and subjected to PC against standard sugars (fructose ,glucose, galactose, glucuronic acid and gulacturonic acid) using solvent system BAW (4:2:1,v/v) and aniline oxalic acid mixture as a locating agent.

Table (4): Assignment of NMR Spectrum

CH_3	PPM	H	PPM
24	0.94	H-12	5.4
25	0.5	H-16	5.3
26	0.6	H-3	3.3
27	1.3		
29	0.9		
30	0.7		

Table (5): NMR spectrum of sapogenin II.

The NMR spectrum of sapogenin 11 showed the characteristic hump of steroidal compounds from 0.6 to 1.8 ppm including 6 methyl groups as shown in the table (4).

CH_3 groups	PPM	H	PPM
C18	0.57	H-16	5.48
C19	0.98	H-17	4.30
C25	0.00	H-3	2.51
C27	1.3	H-24	2.48
	1.48	H-20	

The result of the separation by PC revealed the presence of two spots at Rf values 0.18 and 0.35 which are similar to those of gluconic acid and galacturonic acid, and glucose and galactose respectively.

However,Quershi and Thakur (1977) in a similar study, had detected D-mannitol in *Randia tetrasperma (Syn. Catunaregam tetrasperma* using tests for triterpenoids. The sugars obtained on the hydrolysis of the saponins were identified as D-glucose and D-galactose, the later being present in trace amounts

In another study Lapikanon *et al.* (1983) had isolated D-mannitol, a mixture of β- sitosterol and campesterol, oleanolic acid acetate, oleanolic acid 3-α-arbinoside, and mesembryanthemoidigenic acid as a sapogenin from the roots of *Randia siamensis* (syn. *Catunaregam siamensis.*

Detection of other secondary compounds in the diethyl ether residue

The results obtained show that the plate treated with 1% aluminium chloride reagent gave a common fluorescent spot under U.V light at Rf 0.53 in the extracts of the nine species. From the intensity of the fluorescence, it seems that the compounds accumulated at different amounts in the comparable species. On the other hand, the chromatoplate sprayed with ferric chloride reagent) revealed three common dark spots with different intensity at Rf 0.37,0.42 and 0.48. These separated compounds may be tannins (one of the uses of ferric chloride reagent is the detection of tannins). From the above results it can be stated that there is a clear chemical correlation between the nine species under study.

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ABSTRACT

Four aromatic plants, namely *Cymbopogon citratus,Cymbopogon proximus,ocimum sanctum and Pulicara* undulata were chosen for their possible economic use in Sudan.

For the first time,the macro- and microscopical characters of *Pulicaria undulata* herb were determined. General phytochemical screening of the herb revealed the presence of sterols,triterpenes,flavonoids and traces of tannins.While cardiac glycosides,saponins and alkaloids were not detected.The volatile oil yield was found highest between the period of lst January to 20th January;and it ranges between 1.3% to 2.5 % v/w on dry matter base.The physicochemical properties of the volatile oil,which also varied with the time of collection,were also determined.The herb was found to grow in clay or sandy-loam soils.Preliminary studies revealed that the magnesium content of the soil has a favourable effect on the volatile oil yield while the potassium content has a detrimental effect.

Gas chromatography of *Cymbopogon proximus* volatile oil revealed that the monoterpenoids of the oil as percentage are pinene 0.84,Limonene 3.12,citral b 3.36,citral a 2.4,linalool 21.6 dihydrocarveol 35.3 cis-carveol 4.8, while a sesquiterpene alcohol accounted for 18 % w/w of the total oil content.

Cultivation results, as regard the volatile oil yield, of introduced *Cymbopogon citratus and ocimum sanctum* showed a resemblance to those reported internationally; a fact which is encouraging for researchers to implement the possible economic use of these two plants in Sudan.

The above volatile oils were found to possess antibacterial activity against two gram positive bacteria (Bacillus *subtilis, Staphylococcus* aureus);and two gram negative *bacteria(Escherichia coli,Pseudomonas* aeruginosa). The oil of Pulicaria undulata revealed a remarkably high activity against *Staphylococcus* aureus. This activity is highest when compared,in order of decreasing activity to the oils of *Cymbopogon citratus, Ocimum sanctum and Cymbopogon proximus*

Studies of some Aromatic plants grown in Sudan

Volatile oils find their prime application in the Perfumery and Flavouring Industries. These industries are showing continuous development in the Sudan and other developing countries.

Sudan with it's favourable agroclimatic conditions is capable of supporting the growth of many plants including volatile oil-bearing plants. Sudan flora is already rich with these plants which are

either indigenous or introduced. It is thus obvious that Sudan has the potential for row materials required for the perfumery and Flavouring Industries. The fact that "Raw material are always given a prime consideration in the operating cost of any industry", justifies that the above mentioned industries could have a good prospect in Sudan. Hence come the role of R&D in the field of volatile oils in a country like Sudan: Screening of the already existing wild flora for the discovery of new sources of volatile oils on one side; and examining the yield potential of some volatile oils bearing crop plants with an established commercial value, on the other side; should be the best orientation of R&D in this field. The first is to search for new row materials and the second is to support this research with cash crops of known commercial value.

Yield & physicochemical properties of volatile oils from different plant species

Plant	%moisture	% oil yield on dry matter basis	Density d_{20}	Refractive index	Optical rotation	Ester no.	Acid no.
Cymbopogon citratus	80	3	0.9132	1.4852	-0.28	6.5614	6.8540
Ocimum sanctum	62.0	2.7	0.9061	1.4789	-6.57	8.5975	11.33
Cymbopogon proximus	-	1.2	0.8961	1.4698	+36.1	52.00	23.00
Pulicaria undulata	70.5	2.5	0.8740	1.4822	+2.89	83.869	2.885

Moisture content & physicochemical properties of Pulicaria herb at different time of collection

Time of collection	%moisture content	% oil content on dry matter basis	Density d_{20}	Refractive index	Optical rotation	Acid no	Ester no
1st Jan	80.0	2.0	0.8907	1.4682	+2.80	2.88	82.467
29th Jan	77.0	2.5	0.8740	1.4822	+2.89	2.885	82.869
2nd Feb	70.5	1.86	0.8781	1.4672	+2.77	1.145	32.117
10th Feb	67.5	1.72	0.8240	1.4682	+2.45	0.561	15.736
20th Feb	55.0	1.3	0.8230	1.4530	+2.43	0.543	15.448

RESEARCH AND DEVELOPMENT ON MEDICINAL PLANTS IN ETHIOPIA

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Introduction

According to recent estimates, about 80% of the population in developing countries depend on plant medicines to prevent and treat various health problems (1). These plants have been used for millennia to maintain human and animal health.

Until the 16th century where modern health care service was introduced to Ethiopia, medicinal plants were the only available resources to maintain the health of the people. Even after the introduction of western medicine to the country, about 80% of the people utilize herbal remedies for their primary health care needs (2,3). This situation is expected to continue at least in the foreseeable future due to the prevailing socio-cultural and slow economic growth of the country.

Rationale for Research and Development of Herbal Remedies in Ethiopia

The world pharmaceutical consumption in 1983 was estimated to be 88.2 billion USD. In 1977, when the global drug consumption was estimated only 49.5 billion USD, Africa with less than 10% of the world's population accounted for 2-3% of the global pharmaceutical consumption. The developing world with about 74% of the world's population accounted for less than 20% of the total global consumption with average per capita consumption of 3 USD. While the developed world comprising about 25% took the lion's share which accounted more than 80% of the 49.5 billion USD world's consumption of drugs with an average per capita consumption of 34 USD. This picture has remained virtually unchanged during 1983 where consumption of pharmaceuticals in the third world countries was only 17.73 billion USD of the 88.2 billion USD global consumption (4). One can imagine that Africa with the highest population growth in the world and sluggish economic growth will only share the smallest percentage of the world's drug consumption. Moreover, the situation in the then (1980s) war ravaged and famine stricken Ethiopia is estimated to be far worse. Therefore, the majority of world population particularly those in the developing countries like ours have often used the traditional herbal remedies to prevent and treat various ailments.

Among the several reasons which attribute to the continued popularity of traditional herbal remedies, the major ones are:

- More accessibility and affordability of herbal remedies compared with modern drugs.
- Shortage of western trained practitioners.
- Socio-cultural background of the people and
- Most importantly, through "trial and error" methodology over the millennia, man has evolved a corpus of knowledge regarding the therapeutic utility of plants.

The knowledge gained over the millennia has given the modern world a considerable array of drugs. In the industrialized world, 25% of the prescription drugs contain active principles that are extracted from plants (5) and will continue to be a reservoir to serve as drugs, intermediate compounds or models for drug design by synthetic means. Moreover, the contemporary global outlook towards herbal remedies is changing not only because of the above explained facts but also due to increasing awareness about the safety of herbal medicine compared with synthetic drugs.

Therefore, developing countries like Ethiopia should keep up to use their herbal medicines by improving the traditional system of therapy within the limits of available scientific and technological capacities. This is the belief of the Drug Research Department and is strongly committed to help the needy majority of the Ethiopian people.

Strategies for Research and Development of Herbal Remedies

There are two research and development approaches into herbal remedies. Classical or molecular approach: This approach brings natural products into modern therapy and essentially has the goal of acquiring new chemical compounds with biological activity. The sequence of drug development is shown in Figure 1. This approach has the following short comings.

Drug development in this way takes 8 - 18 years

The cost required to develop a drug is estimated to be 15 - 50 million USD, some times even more.

- It lacks simple and suitable techniques for isolation and identification of complex active compounds and/or compounds which render a given medicinal plant biologically active.
- With all the havoc to produce a drug using this methodology, a drug developed in developing countries like Ethiopia may not obtain huge market to be profitable.

Alternative approach: Given the situation that about 80% of the contemporary developing world rely on traditional medicine, the only way of alleviating shortage of drugs is by putting an effort on improvement of these traditional therapies as much as possible with the aid of modern science and technology that we are able to achieve. This alternative approach is based on the urgent need of the large section of the global population particularly to those of us who live in third world countries. This approach takes minimum time to develop herbal based drug and requires much less cost compared with the classical approach. The drug development stages are depicted in Figure 2.

This alternative strategy has common elements and at the same time differs from one country to another. Under Ethiopian context, the following factors are considered for research and development of phytomedicines.

Major health problems in the country

- Health problems that easily lend itself to pharmacological experiments as well as preclinical and clinical studies.
- Health problems that do not have satisfactory cures and

Priorities will be given to study plant species that are:

- Included in pharmacopoeias of other countries.
- Used as nutrition and medicine.
- With ample presumptive scientific literature on its chemical constituents and/or biological/pharmacological activities.
- Species utilized for treating diseases which have no effective therapy in modern medicine and/or to treat ailments for which modern therapy is disproportionately costly.
- Species with export potential and
- Domestic than wild species.

This strategy is expected to produce safe and effective herbal remedies within a short period of time using the meager resource that developing countries can afford.

Major Achievements of the Drug Research Department

Since its establishment as a coordinating office for traditional medicine some 19 years ago, it has accomplished the following main activities.

There is an understanding that research on herbal medicine requires a multidisciplinary technical personnel. With this view, a number of personnels with diverse professions have been trained. However, most of them are not currently engaged in research activities due to various reasons.

Registration of traditional health practitioners have been carried out

- Translation of medico-religious manuscripts from Geez into English has been carried out in order to provide information to researchers in the field.
- Survey of the existing information on medicinal plants and the associated indigenous knowledge have been carried out in different regions of the country.
- Computerized data base system has been established to facilitate collection, assimilation and dissemination of information (traditional and scientific) concerning medicinal plants.
- Safety and efficacy studies on a number of medicinal plant species have been carried out.
- Medicinal plant herbarium has been established and contains specimens of about 600 species which are classified under 81 families.

There is an ongoing project having the objective of developing safe and effective herbal remedies in Ethiopia using the alternative approach of drug development. This project is underway in collaboration with four other institutes in Ethiopia and has selected five pharmacopoeial standard medicinal plant species for its activity.

Huge project document on sustainable utilization of medicinal plants is under preparation in collaboration with other governmental and non governmental institutions which is to be funded by the World Bank.

It is an often said fact that natural and man made calamities have resulted degradation of the ecosystem in our country. Due to this fact a number of our precious medicinal plant species are either threatened with extinction or wiped out from the country. Virtually nothing has been done to avert the situation. Therefore, sustainable utilization of medicinal plants should be kept at the top of the agenda in attempting to develop herbal based drugs. Hence, our future direction is to use all the possible ways of conservation approaches for sustainable utilization of our medicinal plant species. Moreover, the contribution of the community and traditional healers as well as importance of public awareness about the value of medicinal plant genetic resources is expected to play a pivotal role in realizing sustainable utilization of our flora.

Conclusion

Utilization of medicinal plants has evolved through the alleged "trial and error" methodology. This human experience has provided useful drugs for the contemporary world's population. Plants will also continue to provide human being with valuable new drugs for a long time to come.

Majority of the contemporary third world countries depend on traditional therapies to keep their primary health care needs. The actual and potential importance of the traditional therapies and blink future to provide modern health care services to the needy majority at least in the foreseeable future initiates the effort of improving these therapies with the aid of modern science and technology. In this regard, an alternative strategy for the classical system of drug development should be designed based on the prevailing condition of each country and materialized to produce remedies which are safe and effective. To do so, there should be a balanced attitude and research partnership among governmental institutions, non governmental organizations as well as countries in and outside the sub-region.

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INTERNATIONAL WORKSHOP ON INDUSTRIAL EXPLOITATION OF MEDICINAL AND AROMATIC PLANTS IN EAST AFRICA

by

Research Status on Medicinal Plants
Tanzania Experience
At
University of Dar es Salaam
Chemistry Department
Addis Ababa, Ethiopia
16-21 November, 1998

Introduction

Plants are known to be able to make diversity of complex molecules that have a variety of physical, chemical, and biological properties. This has led to the proliferation of extensive research programmes to investigate plants for their constituent substances as drugs. At the University of Dar es Salaam, during the past fifteen years, plants that are traditionally used as herbal remedies, as well as other plant species which are endemic to Tanzania, have been investigated for their anti malarial and other chemical constituents. Recently, these investigations have also included the search for trypanocidal agents. These investigations were initiated in view of the fact that malaria and sleeping sickness are diseases causing untold miseries to many Tanzanians. Therefore, there is a need to establish an effective cure from indigenous resources, such as herbal remedies, which are easily available even at community level.

Facts about Tanzanian Plant ResourcesFacts about Tanzanian Plant ResourcesFacts about Tanzanian Plant Resources

- It is estimated that Tanzanian rain forests have more than 10, 000 vascular plant species (Brena,1978).
- The Tanzanian montane flora alone comprises of more than 2000 species of vascular plants, about 25% of which are not found elsewhere in the world (Polhill, 1968; Lovett, 1986).
- More than 1200 plant species are endemic to Tanzania (Brena, 1978).
- Many Tanzanian plant species have been used for centuries as traditional medicines.

Most of the plant species have not yet studied scientifically for their pharmacologically potent and other economically important chemical constituents (Nkunya & Jonker, 1994).

Hence, scientific investigations of Tanzanian plants for their pharmacologically and other economically important chemical constituents are urgently needed.

Plant Resources and Health Care in East AfricaPlant Resources and Health Care in East AfricaPlant Resources and Health Care in East Africa

Since time immemorial plants have been recognized as major sources of food and medicines. At the moment, plants continue to offer many of the human requirements for drugs, some of which have not received substitutes despite the scientific and technological advancement man has already achieved. Before the development of synthetic chemistry in the 19th century, nearly 80% of all medicines were obtained from plant materials (Farnsworth, 1990). Presently, many people in developing countries, especially those living in Sub-Saharan Africa, still depend on plant resources for their primary health care needs. There is also growing interest in several developed countries on the desire to use herbal remedies for health care and as health-food supplements (nutraceuticals). Unfortunately, however, the knowledge on the use of plants in health care in developing countries is at community level, being in the hands of a handful of practitioners who inherited it from their ancestors. This knowledge is disseminated from one generation to the next only through a word of mouth, since there is no formal written documentation of traditional medical information in most parts of Sub-Saharan Africa. It is through this system of information dissemination that most of the knowledge in traditional medicines may not have reached the subsequent generations and it is therefore continuously getting lost with the passage of human generations even during modern days. In view of this kind of highly secretive transfer of undocumented information, there is, therefore, an urgent need to carry out scientific investigations on medicinal plants, and to document the useful information from these investigations. Furthermore, such investigations will offer a sure way of promoting the use of traditional remedies in health care, through contemporary drug development processes or as herbal remedies for wider application at community level.

Sociologically, some traditional forms of medicine in East Africa and other Sub-Saharan African countries can be considered as the total combination of knowledge and practice used in diagnosing, preventing, or eliminating a physical, mental, or social imbalance, that is based on the socio-cultural and religious background of African communities. Usually the practice relies on past experience and observations handed down from one generation to the next. The medical practice is therefore a reflection of African culture and habits, and it is not based on any recognized scientific framework. The knowledge on traditional medicines obviously originally stemmed from clinical observations and through centuries of mans evolution it has gradually been refined and therefore made more specific. The development of scientific knowledge has gradually led to the establishment of some pharmaceuticals based upon plant resources originally deplored in traditional medicine. Presently, nearly 200 plant derived chemical compounds of known structures are being used as drugs or as agents that lead to the improvement of human health (Farnsworth and Soejarto, 1985). Thus, in Europe about 50% and in the US more than 25% of all prescriptions dispensed from pharmacies have their origin in plants. It is estimated that the presently booming trade in herbal medicines will reach approximately 500 billion US dollars by the year 2000 (Sidler, 1994). It is yet unknown as to what extent has medicinal plant research contributed to the knowledge that has led to the development of medicinally and other useful compounds through synthetic procedures, based on structures of naturally occurring compounds or their derivatives as lead compounds or templates. Unfortunately, most of these developments may not have contributed direct benefits towards fighting diseases in poor communities.

During the past decade or so governments in developing countries as well as the World Health Organization have been promoting the integration of herbal remedies in health care as a supplementary contribution to modern medical facilities, especially in poor rural communities. It is urged that rural communities in most developing countries have practiced herbal remedies for centuries, and therefore the effectiveness and safety of these crude remedies have already been established through long experiences. Although such arguments may be true, they are generally still based on mere speculations, since in local forms of medical delivery the effectiveness and safety of a drug are simply assumed, as no medical records are kept by traditional healers, especially in Sub-Saharan Africa. Psychotherapy also plays an important role in traditionally based medical practices. The traditional healers use herbs as part of a complex treatment schedule, with the aim of harmonizing the sick person with his/her environment. Therefore, plants used as herbal remedies may or may not contain pharmacologically active principles. Thus, apart from the possible curative properties of local herbal preparations, to a large extent, traditional beliefs and the moral interaction and mutual trust and respect between the herbalist and the patient play a crucial role in the treatment. Furthermore, herbal medical practitioners have no established protocols for dose standardization, and for ascertaining the short and/or long-term toxicity of drugs. Thus, the use of herbal remedies without scientifically establishing their efficacy and safety could, in the long run, be detrimental to the very health of mankind. Therefore, there is a need to evaluate plant-based drugs for their effectiveness and safety following scientifically accepted norms. However, it must be realized that these drugs may be effective as single pure compounds, as decomposition products of plant constituents or as a combination of more than one compound in the crude extract.

Rain forests in Africa have a great abundance of floral diversity and therefore these plant resources form a potential source for the development of new pharmaceutical agents. Despite the threats to the biological diversity Africa is facing at the moment, due to, among other factors, man-induced environmental degradation activities, Sub-Saharan African countries still boast of a wide variety of indigenous plant species. The available knowledge on the use of plant preparations in traditional medicines in these countries allows a direct search for drugs and the development of herbal remedies. In other cases, the medicinal usefulness of the plants may not be known, but still chemical investigations might reveal some interesting bioactive compounds. Several examples for such situations are known in the literature and from investigations at the University of Dar es Salaam. It must be appreciated that scientific investigations of plants should form a fertile ground for the development of knowledge.

Results at the University of Dar es SalaamResults at the University of Dar es SalaamResults at the University of Dar es Salaam

1. Antimalarial Agents from Tanzanian Plants: Some of the Available Results

Since 1985 about 120 plant species have been analyzed for anti malarial activity *in vitro* against *Plasmodium falciparum* malaria parasite strains (Weenen *et al.*, 1990; Nkunya *et al.*, 1991; Achenbach, *et, al.*, 1992, Nkunya, 1992, Nkunya, *et al.*, 1993, Gessler *et al.*, 1994, Gessler, *et al.*, 1995, Nkunya, unpublished results). The choice of the plants to be investigated was based on the following criteria:

Ethno-botanical information: The plant is reported to be a remedy for malaria by traditional healers or in the literature.

Chemotaxonomical information: The plant belongs to a family or genus known to contain anti malarial species.

Traditional uses other than malaria: The plant is used as herbal remedy for ailments other than malaria. Such plants are also included in the study because some drugs may be useful for the treatment of more than one disease.

Restricted in occurrence to Tanzania. Such rare plant species have revealed quite interesting results.**Restricted in occurrence to Tanzania. Such rare plant species have revealed quite interesting results.Restricted in occurrence to Tanzania. Such rare plant species have revealed quite interesting results.**

The work on antimalarial plants have yielded a considerably amount of results, including anti malarial activity data of crude extracts and pure compounds from the medicinal plants investigated. The most active plant species are shown in Table 1 and their respective active constituents isolated are indicated in Table 2.

Table 1. Anti malarial activity of plant extracts against *Plasmodium falciparum* strain *K1* *in vitro* (Only results with IC_{50} values not more than 10 :g/ml)

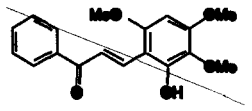
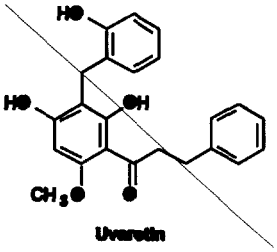
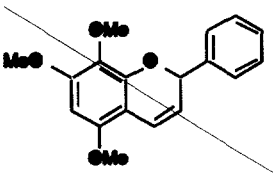
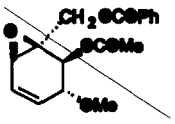
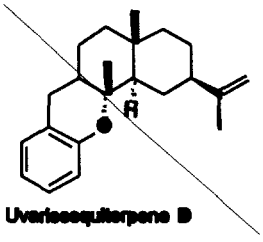
Family	Plant speciesPlant speciesPlant species	PartPart Part	Extract	IC_{50}, :g/ml
Amarantaceae	*Achyranthes asperaAchyranthes asperaAchyranthes aspera*	Root bark	Ethyl acetate	3.0
	Aerva lanata	Aerial	Ethyl acetate	8.6
Ampelidaceae	*Ampelosissus africana*	Leaves	Ethyl acetate	9.0
Asteraceae	*Artemisia annua**	Leaves	Chloroform	3.9
Araliaceae	*Cussonia zimmermannii*	Root bark	Pet Ether	3.3
Bombacaceae	*Adansonia digitataAdansonia digitataAdansonia digitata*	Stem bark	Ethyl acetate	8.2
Capparidaceae	*Maytenus senegalensis* (Morogoro region)	Stem bark	Pet ether	7.5
			Ethyl acetate	0.16
		Root bark	Pet ether	2.0
			Ethyl acetate	0.62
	Maytenus senegalensis (Kagera region)	Stem bark	Pet ether	8.0
			Ethyl acetate	3.0
	Salacia madagascariensisSalacia madagascariensisSalacia madagascariensis	Roots	Pet ether	0.8
			Ethyl acetate	1.6
Chenopodiaceae	*Chenopodium ambrosoides*	Whole plant	Dichloromethane	0.01-0.1
Chrysobalanaceae	*Parinari excelsa*	Stem bark	Ethyl acetate	10
Comretaceae	*Combretum aff.psidiodes ssp psilophyllum*	Root bark	Ethyl acetate	6.5
Cyperaceae	*Cyperus rotundus*	Tubers	Dichloromethane	5-9
	Cyperus articulatus	Tubers	Dichloromethane	1-4.9
Fabaceae	*Erythrina sacleuxii*	Roots	Pet ether	3.6
			Ethyl acetate	3.0
Guttiferae	*Harungana madagascariensis*	Leaves	Pet ether	11
		Stem bark	Pet ether	10
		Root bark	Pet ether	6.0
			Ethyl acetate	4.0
			Ethanol	0.1-1.0
Lamiaceae	*Hoslundia opposita*	Root bark	Pet ether	5.9

Loganiaceae	*Strychnos potatorum*	Root bark	Dichloromethane	1.0-4.9
		Aerial parts	Pet ether	Mild
	Leonotis mollissima	Leaves	Ethyl acetate	9
Malvaceae	*Abutilon grandiflorum*	Roots	Ethyl acetate	10
Menispermaceae	*Cissampelos mucronata*	Roots	Pet ether	8.0
			Ethyl acetate	0.38
			Water	1.2
Myrtaceae	*Psidium guajava*	eaves	Ethyl acetate	10
Sapotaceae	*Mumisops shliebenii*	Stem bark	Pet ether	7
			Chloroform	9.5
				Rubiaceae
Keetia zanzibarica	Roots	Ethyl acetate	4.0	Rutaceae
Vepris lanceolata	Leaves	Water	9.5	
	Root bark	Ethyl acetate	7.0	
Zanthoxylum chalebeum (Dar)	Root bark	Pet ether	10	
		Ethyl acetate	4.2	
		Water	1.2	
Zanthoxylum chalybeum (Kagera)	Stem bark	Water	7.0	
	Root bark	Pet ether	10	
		Ethyl acetate	6.9	
		Water	0.43	Sterculiaceae
Dombeya shupangaeDombeya shupangaeDombeya shupangae	Root bark	Pet ether	8.2	
		Ethyl acetate	7.5	Verbenaceae

L a n t a n a camaraLantan a camaraLantan a camara	Root bark	Pet ether	5-9 0.12	Chloro quine*

* Included as standards

Table 2: Active Principles isolated from antimalarial plant materialsTable 2: Active Principles isolated from antimalarial plant materialsTable 2: Active Principles isolated from antimalarial plant materials

Plant species	Family	Compounds isolatedCompounds isolatedCompounds isolated
Uvaria species ! *U. dependens,* ! *U. kirkii* ! *U. pandensis* ! *U. faulknerae* ! *U. angolensis* ! *U. tanzaniae* ! *U. lucida ssp. lucida* ! *U. leptocladons* ! *U. puguensis* ! *U. scheffleri*	Annonaceae	**Chalcones**  A reversed chalcone **Dihydrochalcones**  **Flavanones**  **Cylcohexene epoxides**  **Sequiterpenes** 

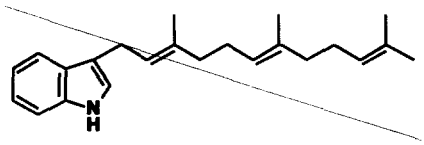
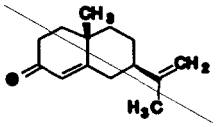
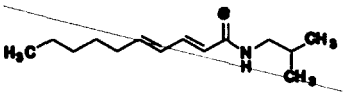
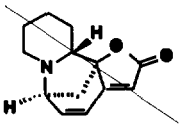
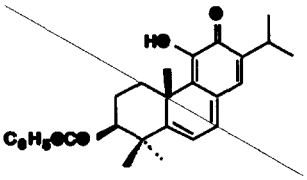
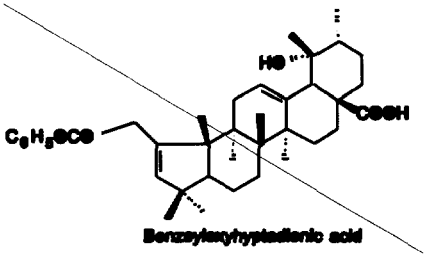
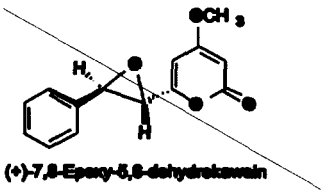
		SesquiterpeneindolesSesquiterpeneindolesSesquiterpeneindoles 

Table 2 (continued)

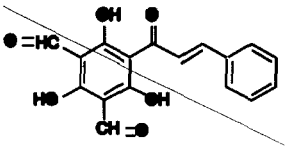
Cyperus rotundus	Cyperaceae	**Sesquiterpenes**  (especially decomposition products)
Zanthoxylum gillettii	Rutaceae	**Fatty acid amides** 
Margaritaria discoidea	Euphorbiaceae	**Piperidine alkaloids** 
Hoslundia opposita	Lamiaceae	**Quinonoid diterpenes**  **Triterpenes** 

Ophrypetalum odoratum Annonaceae **Styrylpyrones**



(+)-7,8-Epoxy-5,6-dehydrokawain

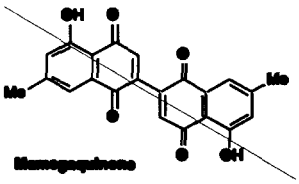
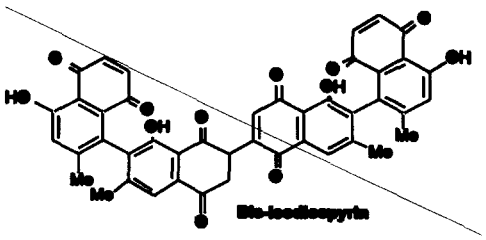
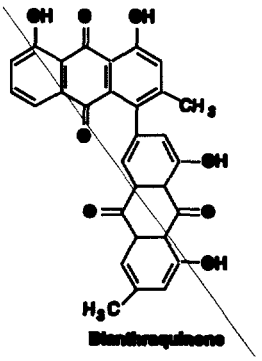
Friesodielsia obovata Annonaceae **Chalcone dial**



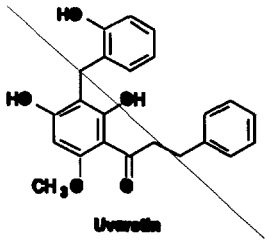
2. Antibacterial and antifungal studies

The studies at the University of Dar es Salaam initially focused on plant species used in traditional medicines for infectious disease: bacterial and fungal. About 150 plant species were screened and some of those which showed activity were analysed for their chemical constituents and active principals were established (Table 3).

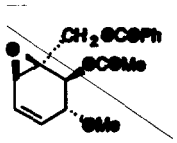
Table 3: Antibacterial and antifungal plant materials and their active ingredients

Plant species	**Family**	**Plant part**	**Activity**	**Compounds isolated**
Euclea natalensis	Ebenaceae	Root bark	Antibacterial	**Naphthaquinones** 
**Several Diospyros species*	Ebeneceae	Root bark Leaves	Antibacterial	**Naphthaquinones** 
Several Cassia (Sena) species	Leguminosae	Root bark Leaves	Antibacterial	**Anthraquinones** 

Uvaria kirkii	Annonaceae	Root bark	Antibacterial	**Dihydrochalcones**

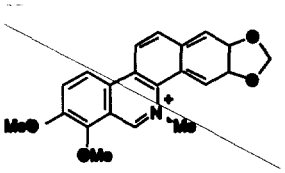


U v a r i a padensis	Annonaceae	Stem bark	Antibacterial	**Cyclohexene epoxides**

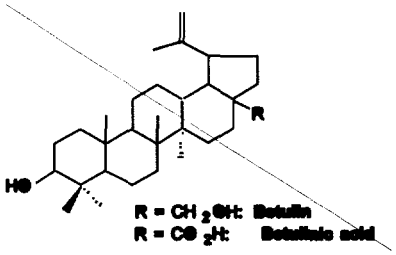


(+)-Pandoxide

Zanthoxylum chalybeum	Rutaceae	Root bark	Antibacterial	**Protoberberine alkaloids**



*Diospyros species were shown to contain large quantities of betulin and betulinic acid. Betulinic acid has recently been shown to have several potent bioactivities, including antitumor, anti-HIV and anti-inflammatory.(Fujiko *et al.*)



3. The Search for Drugs for Sleeping Sickness from Tanzanian Plants

Recently, investigations of Tanzanian plants for their chemical constituents with trypanocidal activity were initiated at the University of Dar es Salaam. In all 48 plant species from different families have been investigated for trypanocidal activity. The plants are those which are either deployed in herbal remedies for sleeping sickness, mostly in East Africa, or the plants are used for illnesses other than sleeping sickness. A few of the investigated plants were not at all used as herbal remedies. Several of the investigated plants species which are deplored as herbal remedies for sleeping sickness actually showed reasonable activities against *Trypanosoma brucei rhodesiense in vitro* (Table 4) (Freiburghaus, *et al.,* 1996a, Freiburghaus, *et al.,* 1996b, Freiburghaus, *et al.,* 1997, Freiburghaus, *et al.,* 1998). Interestingly, however, some of the most active plant species belong to the group of plants that are not deplored in herbal remedies for any ailment. Other most active plant species are used as herbal remedy for ailments other than sleeping sickness.

Table 4. Anti trypanosomal activity of plant extracts against *Trypanosoma brucei rhodesiense in vitro* (Only most active extracts with IC_{50} values not more than 10 :g/ml)

Family	**Plant species**	**Part**	**Extract IC_{50}, :g/ml**	Asteraceae
Vernonia auriculiferaVernonia auriculiferaVernonia auriculifera	Root	Dichloromethane	9.4	
Vernoniasubuligera Vernoniasubuligera Vernoniasubuligera	Root bark	Pet ether	0.8	
	Leaves	Dichloromethane	0.6	Leguminosae
Acacia niloticaAcacia niloticaAcacia nilotica	Stem bark	Dichloromethane	4.4	
		Methanol	4.9	
	Leaves	Methanol	4.4	Euphorbiaceae

*Acalypha hispida**	Leaves	Methanol	5.9	
Hymenocardia acida	Root bark	Methanol	2.2	
Securinega virosaSecurine ga virosaSecurinega virosa	Root	Pet ether	0.5	
		Dichloromethane	2.1	
		Methanol	5.9	Apocynaceae
Alstoniaboonei	Stem bark	Pet Ether	1.4	
	Stem bark	Dichloromethane	1.7	Annonaceae
Annonaseneg alensis	Stem bark	Pet ether	5.0	
		Dichloromethane	0.9	
Annickia kummeriae	Root bark	Chloroform	1.4	
		Ethanol	0.7	
Asteranthe asterias	Stem bark	Pet ether	2.9	
	Root bark	Chloroform	0.8	
Greenwayodendron suaveolens ssp. usambaricum Greenwayodendron suaveolens ssp. usambaricum Greenwayodendron suaveolens ssp. usambaricum	Stem bark	Pet ether	1.8	
		Chloroform	4.0	Caesalpinaceae

Bussea occidentalis	Stem bark	Methanol	0.5	Clusiaceae
Garcinia huillensis	Root	Dichloromethane	4.4	Boraginaceae
Cordia myxa	Leaves	Water	1.3	
Ehretia amoena	Root bark	Dichloromethane	4.1	
	Stem bark	Methanol	9.6	
	Leaves	Dichloromethane	0.9, 3.3*	Ebenaceae
Diospyros mespiliformis	Stem bark	Dichloromethane	9.1	
	Leaves	Methanol	1.9	
Cyperus articulatus	Tubers	Dichloromethane	1-4.9	Fabaceae
Entada abyssinica	Root	Methanol	3.3, 6.8**	
		Dichloromethane	0.5	
	Root bark	Pet ether	1.4	
		Dichloromethane	2.3	
	Stem bark	Methanol	1.3	
		Water	8.4	

Table 4 (continued)

Rubiaceae	*Morinda lucida*	Root bark	Dichloromethane	9.8
Bignoniaceae	*Newbouldia laevis*	Stem bark	Dichloromethane	6.3
Solanaceae	*Physalis angulata*	Fruit	Dichloromethane	1.5
		Fruit	Methanol	2.7
		Root bark	Pet ether	4.0
		Root bark	Dichloromethane	0.3
		Stem bark	Pet ether	2.0
			Dichloromethane	0.1
			Methanol	1.3

		Leaves	Pet ether	2.9
			Dichloromethane	0.2
			Water	7.3
Loganiaceae	*Strychnos spinosa*	Root bark	Dichloromethane	2.5
Rutaceae	*Zanthoxylum xanthoxyloides*	Stem bark	Pet ether	5.6
		Stem bark	Dichloromethane	8.6
			Methanol	7.4
Mimosaceae	Albizia gummifera	Root bark	Dichloromethane	0.07
			Methanol	0.2
			Water	1.7
Verbenaceae	*Lantana camaraLantana camaraLantana camara*	Leaves	Pet ether	1.4
Harmane HCl				2.3
Berberine HCl				0.4
Suramin				0.0107
Melarsoprol				0.0007

*First value is for sample collected in December, and the second in March

**First value is for material collected in August and the second in December

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STATUS OF MEDICINAL PLANTS IN TANZANIA

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Tanzania has a total of over 12,000 higher plant species out of which 3,000 plant species have been documented as having medicinal use based on ethnobiomedical studies conducted in some of the regions of Tanzania mainland. The Institute of Traditional Medicine Research has been established within the Muhimbili University College of Health Sciences with a mission to do multidisciplinary research aimed at enhancing the contribution of traditional medicine in the delivery of health care delivery services in Tanzania.

One among the objectives of the Institute is to conduct and promote field data studies with the traditional healers and traditional birth attendants within communities, documentation and storage of information and materials pertaining to all aspects of traditional medicine. In the course of conducting ethnobiomedical studies, it have been evidenced that most of the diseases differentiated by the healers have a modern scientific equivalent in western medicine. Among the conditions recognised as distinct entities are: anthrax, gonorrhoea, primary and secondary syphilis, urinary bilharziasis, typhus, scabies, meningitis, encephalitis, bubonic plague, smallpox, leprosy, whooping cough, yaws, pulmonary tuberculosis, malaria, intestinal parasitic diseases and trypanosomiasis. Many other diseases, however, are not distinguished in terms of modern medical classification and are grouped either according to the outstanding syndrome, such as diarrhoea, jaundice, fever, cancer, ulcer, etc., or to the part of the anatomy apparently affected, such as mental illness, stomach disorder, etc. The highest percentage of plant remedies belongs to those employed in treating problems of the digestive system, with 32.3%. Other different conditions treated with percentage of plant remedies employed are presented in Table 1. Additionally, the Institute is working towards development of an ethnobiographic and disease atlas in the efforts to bring closer tradional and western health care delivery systems for the benefit of the country at large. The information to be obtained from the latter is expected to be useful to researchers, scientists and practitioners of the two systems and hopefully to serve in the curicula of medical students in the near future.

Parallel to ethnobiomedical data studies, a floristic list of all plant species identified in the course of these studies has been prepared and the specimen are stored in the Institute's herbarium.

TABLE 1: PERCENTAGE DISTRIBUTION OF THE USE OF PLANT REMEDIES

Conditions treated	%Plant remedies
Digestive system	32.3
Genito-urinary stem	21.9
Central nervous system	15.0
Infections	8.6
Problems affecting nutrition and metabolism	7.2
Respiratory system	4.0

Cardiovascular ailments	2.8
Dermatological disorders	1.8
Ophthalmic problems	1.7
Antidote to snake poison	1.3
Ear, nose and oropharynx problems	1.0
Witchcraft	1.0
Others (genetic disorders, contraceptive agents and pesticides)	1.4

INDUSTRIAL UTILIZATION OF MEDICINAL AND AROMATIC PLANTS

In 1983 a UNIDO-funded project for the Institute titled AAssistance for production of Plant-derived Pharmaceuticals@ aimed at utilization of medicinal and aromatic plants was commisioned. Two main objectives of this project include:

a) Development of an industry to produce plant-derived pharmaceuticals that will serve, for the most part, country's drug requirements.
b) To develop an indigenous capability in research, cultivation, harvesting and drying, extraction and distillation of medicinal and aromatic plants, respectively, containing potential pharmaceuticals.

In the course of implementation of the said project, a pilot extraction plant was erected and experimental cultivation of 35 medicinal and aromatic plant species was carried out in four different stations within the country. The latter were selected from international pharmacopoeia and it was envisaged that the experience gained from working with known medicinal plants would be a precedent for developing a pharmaceutical industry based on the indigenous medicinal plants resource. However, due to a number of reasons the implementation of this project could not reach the intended goals. Nevetheless, with little experience gained in this project run up, the Institute is now calling on for renewed efforts to a large scale establishment of medicinal and aromatic plants farms no longer at experimental level, but at fully industrial production level. Obviously funding and market for the expected products are issues remaining to be thoroughly examined.

CONSERVATION STATUS

The moist forest in Tanzania, particularly those on the mountains and coast in the east of the country, are exceptionally rich in endemic plant species in comparison to other places of similar size in tropical Africa (Lovett, 1990). It is in these areas that endemic medicinal and aromatic plants are found. The lowland woodlands, thickets and grasslands are also rich in medicinal plant species. However, the medicinal plants in these ecosystems are threatened by man's activity, since the plants have several other useful applications, example: timber, fuel, construction poles, etc. Currently, ethnobotanical studies covering 45% of the country indicate that medicinal plants like any other element of biodiversity is threatened (Mahunnah, 1991). Also, like in many tropical countries, traditional medicinal plants are harvested from the wild flora rather than cultivated.

To conserve the ecosystem and individual plant species, Tanzania has adopted two simultaneous strategies, i.e. the conservation on maximum plant biodiversity, and focused approach aimed at individual plants species (Mahunnah, 1992). This means that medicinal plants conservation programmes are implemented together with national conservation programmes. The Traditional Medicinal Practitioners, apart from the general public, are also incorporated in the implementation

process. The moist forests are under different categories of protection by the government, for example forest reserves, conservation areas, and national parks (Lovett, 1988). However, they are still subject to different intensities of utilization, e.g., pitsaw logging, cultivation, etc. The unprotected woodlands, thickets and grasslands are still subjected to presure from cultivation, grazing, fuel (firewood, charcoal), logging etc.

The country has some botanical gardens, the biggest being the Mzumbai Botanical garden in East Usambaras, with important medicinal plants, e.g. *Cinchona, Cinnamomum, Eugenia* and *Myrica* species; including rare species like *Saintpaullia* spp. (Usambara violets) which are only known from this area worldwide (Lovett, 1990).

In an endeavour to conserve individual species of medicinal and aromatic plants, the Institute of Traditional Medicine has established experimental medicinal and aromatic plants farms in several parts of the country. There are two categories to these farms, namely, montane farms for temperate-loving plant species and lowland farms for the tropical and subtropical species. There are also other important medicinal and aromatic plants cultivated in the country under the umbrella of agricultural and forest crops.

PLAN OF ACTION

a) Traditional Medicinal Practitioners should be encouraged to propagate their medicinal plants by growing them in their own botanical gardens for sustainable utilization.
b) Relevant University Departments, Forestry Departments and Research institutions should be encouraged to propagate medicinal plants and promote collaborative research programmes.
c) Germplasm should be conserved by collecting seeds of medicinal and aromatic plants. The National Plant Genetic Resources Centre and other concerned institutions should be urged go carry out this activity.
d) Public environmental education as an effective method of action in conservation of medicinal plant species should be promoted.
e) Promote economic mapping of the spontaneous flora to identify the quantitative and qualitative natural resource available in medicinal plants. This should be a cost-effective method of conserving threatened plant communities.
f) Conduct an up-to-date inventory of existing plant species and avail the data to the public for conservation and utilization purposes.
g) Encourage industrial utilization of indigenous plant resource for the production of plant-derived pharmaceuticals.

CONCLUSION

Tanzanian flora is potentially rich in medicinal and aromatic plants. The wealth of the traditional ethnopharmacopoeia of the country' tropical flora is indicated by the high utility of indigenous medicinal plants in the traditional medical system. Scientific work which has been done on the Tanzanian medicinal flora clearly support continued research and development of this renewable natural resource. However, Tanzania needs to develop further her research capability through expert training for the research personnel, and promote meaningful long-term links with other institutions at infraregional, regional and international level in order to realize as sustainable utilization of the medicinal flora ... "Tropical forests are complex chemical store houses that contain many undiscovered biodynamic compounds with unrealized potential in modern medicine" (Eisner, 1988) and the Tanzanian medicinal flora is one of these phytochemical storehouses.

However, conservation of medicinal plants, especially the endangered plants species will depend largely on the conservation of the ecosystems in which they occur (the tropical forests), i.e. *in-situ* conservation. Cultivation of the medicinal plant species (*ex-situ*) conservation) is reasonable but is only a partial solution to the problem since some of these plant species require the ecological niche existing in the tropical moist forests in order to grow and accumulate the desired biodynamic principles. Therefore, sustainable conservation programmes must be based on and supported by genecological exploration and evaluation of the existing germplasm. This should enhance the sound utilization of medicinal plant genetic resources without jeopardizing the germplasm.

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Volatile oils from Tanzania

	Essential oil /origin	Plant source	Plant part	Comments
1	Sandal wood oil	Osyris album	heart wood	yield 8.5% 15/5/98 wild
2	Mhuhu oil	Brachylaena hutchinsii	wood	5% 16/5/98 wild
3	Camphor leaf oil	Ocotea usambarensis	leaf	2% 17/5/98 wild
4	Camphor wood oil	Ocotea usambarensis	wood	8% 20/5/98 wild
5	Sweet basil oil (Zanzibar)	Ocimum basilicum	leaf	1.2% 20/5/98 Exper farm
6.	Basil leaf oil (Mombo)	Ocimum gratissimum	leaf	0.8% 22/5/98 Exper. Farm at Mombo
7	Basil leaf oil (Mombo)	Ocimum suave	leaf	1.0% 25/5/98 Exper. Farm
8	Lemon grass oil (Mombo)	Cymbopogan citratus	leaf	0.7%, 30/5/98 Exper. Farm
9	Citronela oil (Lushoto)	Citronella zizanoides	leaf	1.6%, 11/5/98 wild
10	Oleum chamomole (Olmotonyi)	Chamomilla officinalis	flowers	0.3%, 2/1/98 Expr farm
11	Hyptis oil (Dar)	Hyptis suaveolensis	leaf/Flowers	0.2%, 13/11/98 wild
12	Oleum Lavendula (Olmotonyi)	Lavendula officinalis (Vera)	leaf	0.3%, 2/1/98 Expr. Farm
13	Coriander oil (Kondoa)	Coriandrum sativum	fruits	3%, 5/11/98 Farmers
14	Sweet basil oil (Mombo)	O. Basilicum	leaf	1.5%, 20/6/98 Exper farm
15	Oleum Thymi (Moshi)	Thymus vulgaris	Whole plant	0.5%, 2/5/98 Expr farm

THE MERGING OF TRADITIONAL AND WESTERN MEDICINE: DRUG TRIALS OF HERBAL MIXTURES ON HIV/AIDS PATIENTS

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BACKGROUND

The need to provide a reasonable, affordable and readily available health care to the teaming millions of the developing countries cannot be over-emphasised. This fundamental human right is constantly violated by Western medicine being priced out of reach of the common man while on the other hand, traditional medicine is not developed enough to offer an alternative with safe, consistently reproducible results. Exploitation of our medicinal plants is still pre-industrial and Research and Development is still in its infancy in this region of East Africa.

This great need is focused by the advent of new epidemics like the HIV/AIDS, which are continuing to decimate our communities.

INTRODUCTION

In a bid to fight the AIDS epidemic in Uganda, several herbalists have joined efforts with conventional medical practitioners treat HIV infected patients. Herbal mixtures have become a hope for many where the well researched AZT, DDI, 3TC are too expensive for the ordinary man.

The challenge has been and still is to standardise and harmonise this type of treatment using tools of modern science. This calls for extensive research to establish efficacy and safety of these mixtures besides their preparation and preservation.

To this end, safe herbal mixtures have been tested for efficacy at Joint Clinical Research Centre on a number of HIV positive subjects. These drug trials which yielded interesting results were undertaken using standard modern facilities.

One such herbal mixture called Wampi Wazayirwa (WWL), a liquid from eight different tree barks and one leaf extract was reported as efficacious by one herbalist who is a member of "Uganda Neddagala Lyayo" and has also been HIV infected since 1984. Together with his wife and children he has been a guinea pig for this drug. He was bed ridden when he started taking this drug and has since improved tremendously. He is accordingly supplying the preparation to other infected HIV patients.

Therefore, a phase I and II study for safety and efficacy of Wampi Wazayirwa in patients with HIV infection was conducted by Joint Clinical Research Centre in conjunction with the herbalist

OBJECTIVES

1. To determine whether WWL is efficacious in treatment of HIV/AIDS.
2. To determine any immunological and haematological change in patients on this treatment.
3. To determine clinical aspects on this treatment.
4. To determine any adverse effects associated to this treatment.

STUDY METHODS

Location:

The study was conducted at Joint Clinical Research Centre, Kampala Uganda starting 26th May 1995 to 20th December 1995.

Study patients:

Patients with confirmed HIV infection were screened at JCRC and enrolled if they had a CD4 count $\leq$ 500 cells/mm^3, if they were off antiviral therapy or any continuous medications for a serious infection. Patients were also excluded if they had substantial renal, haematological and hepatic abnormalities. Female patients were screened for pregnancy. All patients were counselled for the study and were recruited if they gave written informed consent and agreed to regular monitoring. A total of 10 patients were enrolled.

Study design:

This was a phase I/II open label non randomised study lasting 5 months. The first 10 clients that were eligible were consecutively enrolled into the study. The treatment was taken in a dosage of 10 mls three times a day.

Medications were dispensed from JCRC every fortnight for 1st month and thereafter monthly when the patients returned to the clinic for evaluation.

Evaluation and Follow up:

Eligible patients had a full medical history, vital signs, thorough physical examination, WHO clinical staging and karnofsky performance score at enrollment into the study. They also had biochemical, haematological and immunological assessment at baseline. These evaluations were repeated every 2 weeks for the first month and thereafter monthly. Safety of drug was also reviewed at each visit. The haematological studies were performed with a coulter counter model T540. Immunological tests included CD4, CD8, CD4/CD8 ratio which were determined by

Flowcytometer (Becton Dickinson Facscan)

Chemistry tests included creatinine, aspartate aminotransferase (AST), alanine aminotransferase (ALT). They were determined using wet chemistry Randox kits.

STATISTICAL ANALYSIS

Analysis was done on all patients who completed week 12, and 20. The software used for analysis were EPIINFO and SAS. The kolmogorov-Smirnov test was used to determine how well each laboratory parameter fits the normal distribution at baseline (i.e if $P<0.05$ then there was doubt on the assumption of normality). The mean laboratory values between baseline and the subsequent weeks were compared using student T-test. For parameters with heterogenous variances or parameters which do not fit a normal distribution, Kruskal Wallis non-parametric test was used with significance determined at 95% level.

RESULTS

Baseline characteristics:

Ten patients whose baseline characteristics are summarised below in Table 1 were enrolled in the study. The distribution of baseline CD4 cell counts by six was significantly different ($P=0.04$).

Sex	Mean	Median	Standard
Male (6)	114.5	70	141.96
Female (4)	333	333	165.46

Table 1

No of patients	10
Male sex no. (%)	6 (60%)
Female sex no. (%)	4 (40%)
Mean age	35.5
Mean weight	57.4
Median CD4 counts cells/mm3	84.0

Treatment period:

7 patients completed the first 8 weeks of the study, 6 completed 12 weeks and 5 completed the 20 weeks of follow up. Of the 3 clients who did not complete the first 8 weeks, one withdrew consent after initial visit, another was lost to follow up after 4 weeks on study and the third died in 3rd week on study possibly from PTB. Two more terminations before week 20 were due to loss to follow up and development of PTB and subsequent death.

Adverse effects:

There were no reported adverse events during the treatment phase of the study. No adverse biochemical changes were associated with the drug. Three clients had a more than 50% reduction in ANC at week 2, 4 and 16. The decline reverted to normal at the subsequent visits. One of these clients had a corresponding reduction in WBC of more than 50% at week 4.

Immunological effects:

The immunologic sequelae of the antiviral effect of WWL are shown in figures 1 - 8. Patients had a median decrease between baseline and week 12 of 24 CD4 cells/mm3 (15%) and a mean increase of 23 cells (10.9%). Patients who completed 20 weeks of follow up had a median CD4 cell increase of 64 cells/mm^3 (29.6%) and mean increase of 37 (15%) cells/mm^3. There was also a median increase in the CD4/CD8 ration of 0.01 and an increase in the mean lymphocyte levels between baseline and week 20 of 0.2. The increaments did not reach statistical significance.

Clinical parameters:

Most of the patients showed stabilisation or increase in their weight during the months of follow up. There was an increased sense of well being as reflected by quality of life questionnaires filled at each visit and the karnofsky performance score. There were noticeable changes in appetite and general malaise.

DISCUSSION

This study assessed the safety and efficacy of WWL. Generally the drug was well tolerated and no adverse event was reported. The laboratory abnormality associated with therapy was reversible reduction in ANC for 3 patients at weeks 2, 4 and 16 and one of these with a corresponding decline in WBC at week 4. There was no biochemical abnormality attributable to the drug.

Antiretroviral or immunomodulatory activity as measured by a rise in CD4 counts was observed after week 8 of therapy with mean increase of 23 cells at week 12 and 38 cells (mean) and 64 cells (median) at week 20. These increaments may be a result of decreased rate of CD4 cell destruction though they did not reach significant levels. Significance may be reached if there are more patients to be evaluated or if the higher dosages of WWL are given. Future studies should investigate higher dosages.

In conclusion, WWL is a safe preparation and caused a sustained rise in CD4 counts after week 8. This immunologic response may reach statistically significant levels at higher dose levels.

Industrial Utilization Of Medicinal and Aromatic Plants In Ethiopia

Essential Oils Research Center
by
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Nov., 1998
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1. BACKGROUND

Ethiopia being situated along the equator having cool high mountains, low scrublands, deserts and river gorges undoubtedly has a remarkably diverse species of aromatic & medicinal plants.

The people of Ethiopia in the course of their long history learned much about the therapeutic qualities of the country's flora eventhough that this great natural resource has not been yet utilized in the production of therapeutics.

Due to the great economical significance and vital social importance of pharmaceutical industries, it becomes a focus of attention, especially to the developing countries like Ethiopia which possess rich diversified flora.

As in other parts of the world, the Ethiopian people resort to the use of medicines to relieve symptoms and cure diseases. Among several traditional health practices in Ethiopia, practice with the use of herbs is the major one.

It has been reported that the great number of the Ethiopians population is estimated to have no access to modern medicine. Those people rely on traditional medicine. Medicinal plants, the major ingredients of traditional medicine, contribute considerably to modern medicine.

It has been estimated that developed countries spend about 12.5 billions on plant based remedies (Cathy 1995). More than 40 % of medicines were of biogenic origin in Germany as at 1984. It was also reported by UNCTAD that in the early 1970s, plant-derived drugs accounted for 33% of the total drugs produced in the industrialized countries. Under African conditions and needs, the percentage of plant-derived drugs produced by African countries can be and should be higher than 33% (UNECA). In other words, the potentials for supplementing and substituting some of the drugs imported is high and therefore worth considering.

As to the current market assessment plant derived chemicals take the major share of the $100 billion pharmaceutical production (OECD 1992).

The region in which Ethiopia is located is rich in flora (medicinal and essential oil bearing plants) possessing an enormous diversity in plant genetic resources making it one of the Vavilove centers.

Its location (along the equator) and variation in altitudes make it also possible to introduce plants not indigenous to the region. In other words, it has a large potential to produce and process medicinal plants, including those that are exogenous to it.

From the above it is apparent that drugs from medicinal plants offer great opportunities to develop the pharmaceutical industry with medicinal plants as raw materials. This potential should be exploited with a view to maximizing the use of drugs from medicinal plants.

To maintain the supply of medicinal plants at todays level cultivation is the main hope for maintaining many of the medicinal plants as todays level (Lambert 1997). This is due to the decrease of the wild resource, in sustainable supply and inadequate quality control. Moreover, the botanical identification of the plants is also dubious and gives chances for adulteration.

To avoid this ambiguity the process of cultivation & the production of raw materials (plants) can be increased, the supply should be sustainable & hence the quality can be better assured and the identified species can be secured. Yield can be manipulated by agronomic means such as fertilizer, pest control and better cultural practices.

Some of the Traditional Medicinal and Aromatic Plants of the Country are the following:

Adhatoda schimperiana
Ajuga integrifolia
Aloe spp.
Artemisia rehan
Asparagus asiations
Boswellia spp.
Chenopodium album spp.
Croton macrostachyus
Cymbopogon spp.
Cyperus spp.
Datura spp.
Echiunops sp.
Eucalyptus globules
Euphorbia spp.
Hagenia abyssinica
Jasminum floribundum
Jatropha spp.
Lepidium sativum
Moringa stenopetala
Nigella sativa
Ociumum lamufolium
Olea africana
Phytolacca dodecandra
Plantago lancolata
Punica granatum

Ricinus communis
Rumex spp.
Ruta chalepensis
Schinus molle
Spilanthes mauritiana
Stephania abyssinica
Thymus schimperi
Trichilia raka
Trigonella foenum - graecum
Verbascum schimperi
Vernonia amygdalina

Inspite of the existence of such abundant and varied flora in Ethiopia, processing of the derived chemicals from this flora into intermediate products and/or isolation of active principles is not being done due to the lack of suitable scientific and technological infrastructure necessary for the development of appropriate technology and its transfer to industry.

Regarding the pharmaceutical production in Ethiopia there are two Ethiopian Pharmaceutical Enterprises (EPHARM and the newly established Addis Pharmaceutical Factory Pvt. Ltd. Company in Adigrat, Tigray). Both are formulating medicines from imported drugs.

The limited availability of foreign currency and the high prices of pharmaceuticals aggravated by fluctuating exchange rates have made and will continue to make pharmaceuticals beyond the reach of the increasing number of people in Ethiopia.

Since the region in which Ethiopia is bestowed her with various favourable environmental conditions, there is a possibility to cultivate various types of aromatic & medicinal plants.

While the cultivation of the selected plant species are underway yield maximization trials(agronomic studies) by using better inputs and applying improved cultural practices will also be conducted. The cultivation of these plant species insure a uniform supply of raw material for the envisaged drug formulation which is the major draw back when dealt with raw material of plant origin . Further more primary processing of the plant material such as drying, cleaning etc. will also be carried out.

2. R & D ACTIVITIES

Fragmented and isolated research and development activities on plant derived chemicals are ongoing in different institutions in the country. However, academic research is also being conducted confined to extraction and isolation of components, elucidate structure in the laboratory for awarding degrees and publication of research findings.

In Ethiopia there are few organizations engaged in R & D aspects of aromatic and medicinal plants.

2.1 Department of Drug Research (DDR) of the National Health and Nutrition Institute

It is a major governmental institution which is engaged in the study of medicines and medicinal plants used traditionally. The preliminary biological and pharmacological screening on some of the medicinal plants carried by the department revealed that some plants have very promising potential. They are under intensive trials. The department has set up a computerized data base and housed information on many traditional therapeutic preparations involving different0 medicinal plant species. A herbarium is also established in the department.

2.2 Other Institutes Dealing with Medicinal and Aromatic Plants

Chemistry Department of Addis Abeba University

It is working on various phytochemicals through the special-Natural Products Research Unit which deals with isolation and characterization of individual substances from plant materials. The research activities of this unit are not connected only with medicinal plants but also with plants having great potential to the food, perfumery and other chemical industries. Chemical constituents of medicinal plants, essential oils, gum arabic, cotton seed etc. are being analyzed.

Biology Department of Addis Abeba University

It is the pioneer in the medicinal plants research especially in collection and identification of plant species. Eventhough the project on the Ethiopian Flora (coordinated by the department) is not yet completed, the National Herbarium at the department has a collection of about 50000 specimens among which about 500 are medicinal plant species.

School of Pharmacy of Addis Abeba University

It is also a pioneer in medicinal plants research. Through its various departments it has carried out a number of biological and pharmacological studies on medicinal plants.

Institute of Pathobiology of Addis Abeba University

It has done a lot and still is working on the Ethiopian high land plant "Phytolocca dodecandra" locally known as "ENDOD" which is used locally as effective soap with strong bleaching action. "ENDOD" was found to possess a pronounced moluscicidal property against snails transmitting a rapidly spreading parasitic disease known as schistosomiasis. This property of "ENDOD" was discovered by an Ethiopian Biomedical scientist Aklilu Lemma.

Among the various plant species "ENDOD" has reached the stage of commercialization.

Different institutions like the Institute of Water Technology conducted a research on natural coagulants for water purification; Institute of Agricultural Research, Ministry of Coffee & Tea Development, Ministry of Agriculture and others have made some studies mainly on the field of agriculture.

2.3 Essential Oils Research Center

It is a governmental institution engaged in R&D and pilot plant production activities on essential oils and other plant materials. Since 1987 it has acquired about 80 ha of irrigable land at Wondo Genet with a French type pilot plant distiller with a distilling capacity of about 1-2 ton/day of green herb. The center produces different types of essential oils which are being produced for marketing at a pilot level. In addition to this, methods of product maximization are being studied. The center has a moderately equipped laboratory which is built and assisted by foreign donors such as the Swedish Agency for Research Cooperation with Developing Countries (SAREC/Sida). Very recently the center has established a mini laboratory at the production site for preliminary distillation and analysis purposes.

The plants under the research are essential oil bearing plants, insecticidal plants, medicinal, tanning plants, oil seeds etc. Some essential oil bearing plants and some other plant species are under various stages of studies i.e. collection, observation, production etc. The institute is equipped and assisted with adequate infrastructure (agricultural machineries, tools, offices, shades, buildings, water and power supply with a standby generator, steam generators etc.) and necessary man power (agronomists, chemists, laboratory technicians and field workers etc.).

2.3.1 Objectives

- To promote R&D activities on traditional medicine systems with a view to further study their use within the framework of existing national health system.

- To promote the study of aromatic & herbal remedies used by traditional practitioners i.e. their ethnobotanical, medical, anthropological, chemical and clinical aspects.

- To collect, analyze and disseminate information relating to traditional medicine.

- To participate with other WHO collaborating centers for traditional medicine in joint studies aimed at evaluation of national traditional medicine systems.

- To evaluate traditional medicine in the light of modern science, to maximize useful and effective practices and discourage the harmful.

- To promote, stimulate, organize and direct multidisciplinary research on aromatic chemicals & traditional medicine in the country.

- To contribute significantly to the development of the agro-industry, in product diversification, in earning and saving of foreign currency.

2.3.2 Research Center's Activities

- Collection and selection of appropriate plants from different areas. This could be from the country and also from abroad

- Agronomic studies are being carried out on some of the collected plant species. The trials include fertilizer type & rate, harvesting time, frequency and other relevant parameters which are thought to influence quality and yield of oil.

- Identification of various regions of the country where essential oil bearing plants could be cultivated have been accomplished. Further studies and verifications will continue.

- Extraction and characterization of some essential oils for their oil contents and chemical compositions have been carried out. In the future this activity will be further strengthened.

- Oil samples have been distributed to some private producers, mainly to soap and cosmetics manufacturers. The application methods and the results were evaluated for the substitution of imported essential oils.

2.3.3 Outputs Expected

Outputs of the research center will be:

- A fully established medicinal plant products development and production center consisting of:

a) Operational technology development unit
b) Operational quality control laboratory
c) Extension/training unit
d) Information and documentation unit

- A document containing description of the R&D and pilot scale achievements
- A detailed techno-economic analysis of the trials
- Trained technical personnel
- A suitable processing and production methods of the raw materials
- A suitable application based on the generated data
- Screened suitable plant varieties
- A domestic contribution to the agro-industrial development in the rural sector

2.3.4 Inputs Needed

- Additional equipment & components
- Buildings, services, manpower etc.
- Data bank, journals, books
- International & National expertise
- Training & study tours

3. Industrial Production

Aside from the pilot scale production of EOs which amounts to about 2-4 tones/year there is no production of essential oils in the country. However, there seems to appear some distillation unit with its own farm for the raw material production.

There are two spice extraction factories engaged in the production of oleoresin of paprika & ginger, the Ethiopian Spice Extraction Enterprise and KASSK Spice Extraction Company which have an annual installed capacity of 155 and 120 tons of production per year respectively.

4. Local and Export Market Situation

One to two tons of essential oil is sold locally in each year. Export of oleoresin from capsicum and ginger is well established. Quite a substantial amount of frankincense (aromatic gum) is also exported, although very insignificant export of Eos has been started.

5. Constraints to the Development of the Industry

The production of EOs being relatively new in the country there are a lot of constraints to develop this sector. These include:-

- In general the awareness in the field is far from satisfactory
- The number of authenticated and botanically described EO bearing plants are very limited
- Agricultural practices which suits the local conditions are not yet developed
- Trained manpower and know how in the field is very limited
- Lab. equipments, consumables etc. for quality specifications are not available
- Lack of due attention given to the sector is not sufficient

6. Constraints for Transferring R & D Results to Industry

The country being food deficit priority is given to food crops followed by traditional cash crops. The awareness of the farmer about the production of essential oils is nonexistent. Further more, the processing equipment i.e. the distillation unit requiring investment and know-how is one of the limiting factors to the transfer of R & D results to the Industry.

7. Technical Assistance Requirement

Research and Development in the field of Eos and medicinal plants in general can be said that it is at its infant stage. Very limited experts are working on EOs. On the other hand interest has been observed to develop EOs production in the country. These would necessitate technical assistance in training, technology transfer, market information, lab. equipment and pilot scale units so that good results could be attained.

8. Possible Technical Cooperation Among Developing Countries in the Region

- Exchange of authenticated plant materials
- R & D know-how exchange
- Package development for specific crops
- Adoption of technology
- For EO analysis requiring sophisticated instrument share the analysis work where the instrument is available

9. Socio-Economic Importance

The country having a wide variety of climatic zones and a large rural population who needs employment it is very essential to develop agro-based industry such as the production of medicinal plants and essential oils.

The relative simplicity of the processing of essential oils production and being an agro-based industry attracts the rural sector.

The production of plant derived chemicals is an industry that blends well with the development goals of many developing countries. It is an important industry, generating goods that bear a high value to weight ratio.

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Industrial Exploitation of Medicinal and Aromatic Plants in East Africa

by
Michael M. Kimani

Objective

Self sustaining industrial enterprises
The Kenyan experience

Industries that are involved in their raw material production survive best

Examples:

Pyrethrum Board of Kenya: Although this organisation buys and sells all the pyrethrum grown in the country, it collaborates with small scale farmers who cultivate the crop.

British American Tobacco (k) Ltd: This company contacts tobacco agricultural inputs, supervises the farmers to ensure that as they grow tobacco, they also grow enough trees for the curing process. It has also been involved in the development of more efficient tobacco curing kilns.

Governments Forest Department: Most of the forests are government owned and they support a thriving timber industry. This how been achieved by allowing squatter farmers into the forest reserves: They are allowed to cultivate the areas where trees have been cut down in return, the plant seedlings provided by the department and tend them along with their crops. After harvest time, they move into a new area.

Kenya Planters Co-operative Union: This is a farmers union that over seed coffee production: It provides agricultural inputs to the farmers on credit terms. In turn, the farmers deliver their coffee to the union for processing and sale. Before payments are done, the debt include is first of all recovered.

East African Tanning Extraction Company: The company owns vast amounts of land. On which it grows black wattle trees for their bark. There backs are used for extracting tannins for the leather industry.

Qat Cultivation: On the eastern slopes of mouut Kenya, individual farmers grow "got" trees along with their regular crops as a cash crops. Because of the economic value attached to these trees, they are tended and protected very carefully.

Medicinal and Aromatic Oil Industry

The medicinal and aromatic oil industry in Kenya can be divided into three:

- Formal Industrial Units
- Informal medicinal practices.
- Formal Medicinal Exploitation's

This is dominated by the cultivation of pyrethrum flowers and its subsequent seamy-processing. The production and marketing of pyrethrum extract is regulated by pyrethrum Board of Kenya.

Pyrethrum are very powerful insecticides. The main ingredients are : Pyrethrin I Pyrethrum II

Kenya is the world biggest producer of pyrethrum flower. Other components are: Cinnerius and Jasmolia. The latter compound is quite undesirable for it seems to induce skin irritations in some people.

In the last 3 years or 20, a small scale perfume making unit has come up in Mombassa. This factory uses flowers as the source of the perfume aromatic. It produces for both local and export markets.

For medicinal trials, there is a unit in the Kenya Medical Research Institute (KEMRI) that is supported to local into traditional herbal medicines, and subject them to modern scientific analysis. Although herbal medicine is available quite readily in the country, the activities of this unit are not widely known.

In Limura, a private herbal clinic has started operations. If goes by the name of KAMIRITHN HERBAL CLINIC.

Despite this poor reputation particularly amongst the educated, herbal medicines are still in common use; I am familiar with the use of some plants whose names I Knoco in the local languages.

KIKUYU

Amongst the Watikugu people, a creeping plant known as "mubuthi" is used to "strengthen bones" or faster healing if the are broken. The leaves of this plant are boiled and with meat and the ensuring bitter broth is drunk. The biter extract is also said to prevent nausea s a result of excessive fatty meat consumption.

Castor oil was commonly used to treat open wounds. Very after though, it would be mixed with the powder obtained from a small yellowish-grey fungus known s "dogamuuki" for faster healing.

The "thabai" and "Njegeni" are plouts that have broad, dark green lease that lease a burning sweastion on the human skin. The extract obtained by boctiy there leaves is said to e able to treat fever, including malaria.

WASWAHILI

Amongst the klaswahili people of Kenya, the "Mrubaini" plant is reputed to treat a wide variety of disease. The active ingredient are obtained by boiling the leaves, the roots or both of them: fever, headaches and hypertension are just sole of the disorders it is reputedly able to leaf.

LUO/LUHYA

When news of "viagara" came to Kenya, reported started coming from western Kenya from the Luo and Luhya of the "omogombero" plant that men in the region have used since time immemorial "to make their breath clean" by chewing it and also, "to make them appealing and satisfying sex partners."

Others: "Qat" is after chewed by long distance drivers to ward of fatigue and hunger.

Informal Herbal Medicines

This is dominated by the production of "Qat" or as know in Kenya, "Miraa". The cultivation of this plant is done mainly on the Eastern Sloppier of meuut Kenya. The main market for this commodity is in Nairobi and also, the Saudi Arabian peninsula.

In Kenya, got is chewed by long distance vehicle drivers who say that it helps them remain alert and fresh for many house. Often however, it has become a social activity, being chewed to pass the time - No processing is done whatsoever to the commodity.

On the streets of many towns in Kenya, are will coup across derhisments announcing:

- Doctor of Botanical Medicines
- Doctor of Traditional Medicines
- Herbalist

All these refer to traditional herbal treatments for various claimants. These traditional herbals are however registered with the Ministry of Culture and Social Services, and not with the Ministry of health. In times past, they have operated as other ordinary however or shoppers.

- Many of these herbalists also double up as:
- Fortune tellers
- Klizards and soceeron.

Welcoming address

Your Excellency, Ato Bruk Debebe,
Vice Minister, Ministry of Trade and Industry
Mr. Ambassador, the Ambassador of the Italian Embassy in Ethiopia
Dr. David Tomy, UNIDO Country Representative
Dr. Karan Vasisht, ICS - UNIDO Representative
Distinguished Scholars, Workshop Participants

Ladies and gentlemen,

On behalf of the entire staff Institute of Biodiversity Conservation and Research (IBCR), the Essential Oils Research Center (EORC), the hosting and organizing Institutions and Dr. Tadele, Head of EORC and myself, it is indeed my pleasure to welcome you all to Addis Ababa for this subregional training workshop on Industrial Exploitation of Medicinal and Aromatic Plants this august morning.

First of all, I must express that it is a great pleasure for us that the regional workshop is held here in Addis at the Biodiversity Conservation and Research Institute (IBCR) with an immense support from the Essential Oils Research Center. I must confess, from the start that the workshop has been co-hosted and jointly organized by IBCR and EORC all the way from inception to the present moment and of course to the final stage of the workshop.

This training workshop is designed to provide participating countries and individuals in the Eastern Africa sub-region an updated information on the industrial exploitation of medicinal and aromatic plants as well as to come up with action oriented recommendations and proposals on a systematic and integrated approach towards medicinal plant-based industry and ensuring sustainable development of the sub-sector in Eastern Africa. It is also designed to strengthen pertinent activities by promoting regional network in the field of industrial and sustainable utilization of medicinal plant biodiversity in the sub-region. I hope, the sub-regional cooperative activities will further be promoted through the success of this workshop.

Your Excellency, Ladies and Gentlemen

In this occasion, I would like to explain the changes that our institution is going through. The former Biodiversity Institute is in the process of developing into a Biodiversity Conservation and Research Institute and is placing a great deal of emphasis on neglected aspect of biodiversity including medicinal plants. In the course of the development, we are placing great importance on conservation and the sustainable utilization of biodiversity across the board i.e. plant, animal and microbial genetic resources.

According to a recent study, it is estimated that there are over 7000 species of plants recorded for Ethiopia of which 12 % are probably endemic. Over 600 species are known to have medicinal value and more than 80% of the rural and urban population (about 45 million people) and the animal husbandry employ many of these species as part of the primary health care delivery system. This traditional health care system is believed to continue into the future because it is both viable and culturally integrated system for the majority of the population. Moreover, the modern health care service is both limited and expensive.

In recognition of these facts, great attention is being given to the collection, conservation and sustainable utilization of medicinal plants. Currently, IBCR in collaboration with other sister institutions and various stakeholders is developing a comprehensive project document to be submitted to the government which among others things, include emphasis on conservation and sustainable utilization of medicinal and aromatic plants.

As part of the project objective, plants with established safety and efficacy records for the treatment of the major health hazards have to determined and standardization of their active ingredients and dosage form will be developed. This project is envisaged to include pilot cultivation and production to minimize the danger of collecting from the wild and certainly this process will enhance the involvement of the private sector all the way from cultivation to community-based industrial production of phythomedicine. This workshop is, in a way, timely and extremely useful for us who are under going through the preparatory phase of the project

Your Excellency, Ladies and Gentlemen

We fully understand that it is important for many countries and international organizations to work together and exchange experiences and information in order to deepen mutual understanding and further promote collaboration on pertinent subjects and issues of importance to the sub-region. We hope that the workshop will come to a fruitful results through interactive participation and discussions by the participants. The background papers to be presented will provide the basis for discussions and interactions that follow. Through discussions and understanding further cooperation between institutions will be developed in the field of phytomedicine and related areas.

Furthermore, I hope, this forum will provide us the opportunity to be in a position to come up with proposal and recommendations that will assist our sub-region in concentrating on appropriate activities in the field of medicinal plants utilization and development of standardized pharmacopoeia. It is my firm believe that we will gain a great deal from the experiences and knowledge base that have been accumulated over the years both at national and sub regional levels.

May I finally take this opportunity to express my gratefulness to His Excellency Ato Brook Debebe who has graciously accepted our request to officially open the workshop and deliver a key note address in spite of his tight schedule. His presence here today is a practical demonstration of his personal commitment to the growth and development of this indispensable sector.

I would also like to thank the resource persons, participants and those who have shown keen interest to participate and share their views and experiences with us here today. My gratefulness also goes to the funding agencies especially UNIDO and ICS and of course the individuals behind this useful exercise.

I thank you all.

Nov. 16/1998

Opening Address

"Training Workshop on Industrial Exploitation of Medicinal and Aromatic Plants in East Africa"

by

Ato Biruk Debebe

Distinguished Scientists

Workshop Participants, Ladies and Gentlemen

It gives me great pleasure to be with you at the official opening of this workshop on "Industrial Exploitation of Medicinal and Aromatic Plants in East Africa". The workshop is of great value because it is a gathering of international and regional scientists who has been dealing with the above mentioned subject from many years.

Our East Africa region encompasses one of the Vavilovian Centre of Diversity, Ethiopia. According to recent studies it has over 7000 plant species of which 12% are endemic. Among these plants there are wild and weedy relatives of the cultivated plants as well as lesser known but potentially useful plants.

Many plant species have been and are still being used traditionally among the rural society for various internal and external treatments as a long standing heritage in the course of therapeutic qualities.

Their economic contribution to agricultural growth, national primary health care and pharmaceutical development, industrial exploitation and environmental concern both at national and international levels is great.

Though these countries have a great natural resource potential in these regard, they have not yet utilized the resources for their development. Considering the economic significance and vital social importance of pharmaceutical industry it is a focus of attention to researchers in developing countries to exploit the existing potential for future pharmaceutical developments. The establishment and strengthening of such sectors in these countries should be taken as primary target for the promotion of research oriented out comes to over come the challenges in the field of medicines and aroma chemicals.

As a result of deforestation, natural calamity and agricultural practices, valuable aromatic and medicinal plants are lost. This is likely to continue unless drastic measures are taken.

According to the Washington Convention of 1973, "Protection of Plants against Extinction" efforts are necessary to collect and domesticate a large number of medicinal and aromatic plants dispersed in the wild whereby special attention is given to the outstanding, but diminishing flora.

An International Consultation on the Conservation of medicinal Plants organized by WHO, IUCN and WWF in Chaing Nai Thailand in 1976 has realised a declaration entitled "Saving Lives by Saving Plants". On this occasion grave concern has been expressed that many of the plants provide traditional and modern drugs are threatened, and therefore, urgent need exists to establish conservation programs for medicinal plants to ensure that adequate gene materials are available for future generations.

Taking into account the current problem of our countries like ecology degradation, population explosion, etc. there is a need for severe restriction of various genetic resources requiring high conservation, protection and also domestication measures.

Here in Ethiopia there is a great diversity of plant germplasm which is the result of several factors, including the geographical position of the country and the wide variation in climate, geographic and topographical factors. Ethiopia is long committed to the conservation of her biological resources reckoning the severity of the problem. The Biodiversity Institute which collects, conserves and enhances the utilization of plant germplasm has been operating since the mid-seventies. The Institute has assembled over 56000 accessions of primarily cultivated crops from various agroecological zones in the country. Recently the Institute's mandate has been expanded to include not only plant genetic resources, but animal and microbial genetic resources. The conservation and sustainable utilization of plant germplasm will remain high in Ethiopia's list of priorities and medicinal plants deserve more attention than has been the cases in the past.

Medicinal plants, the major ingredient of traditional medicines contribute considerably to the development of modern medicines in a number of ways. For example, they could be used either as major components or as supplementary starting material for the manufacture of modern medicine.

In developed countries such as the USA, about 25% of prescriptions dispensed from public pharmacies during 1959 and 1980 were found to contain material of plant origin. More than 40% of the medicines produced in Germany were of biogenic origin.

UNCTAD has reported that plant derived drugs accounted about 33% of the total drug production in the industrialized countries. In Africa given the availability of medicinal plant materials, the percentage of plant derived drugs produced could be higher than 33%.

In other words, the potential for supplementing and substituting some of the improved drugs is high and, therefore, worth considering.

Besides the recent increased interest in plant derived medicines and popularity of herbal remedies in developed nations the industrial production of the materials in the countries endowed with rich flora should be encouraged.

Though at initial stage some attempt are being made to exploit this rich flora in our country.

The development of such industries would not only create additional employment but also would benefit the rural population with new technological inputs. The rural work force could benefit both from the industry and the peasant participation in the cultivation and harvesting of the raw material and to some extent in the processing.

Dear Workshop Participants:

It is hoped that this workshop will address:

- The current status of medicinal and aromatic plant based industries in this region compared to the global scenario.
- The issue of sustainable supply of medicinal and aromatic plant species.
- Problems related to the industrial development of medicinal and aromatic plants.
- Assessment of the available technologies.
- The cooperation of institutions in the region dealing with industrial exploitation of medicinal and aromatic plants.

It is my feeling that the above issues are worth considering seriously and if this is achieved the workshop has fulfilled its objectives.

Ladies and Gentlemen

I sincerely hope that the present workshop will be successful and useful for promoting industrial exploitation of medicinal and aromatic plants in our region. I also hope our cooperation will be further strengthened through our joint efforts in reaching this common target of immense importance.

Finally, on behalf of the Ministry of Trade and Industry and on my own I would like to thank the United Nation Industrial Development Organization (UNIDO) and the International Centre for Science and High Technology for providing the financial assistance to organize this workshop. I would also like to commend the Biodiversity Conservation and Research Institute and Essential Oil Research Centre that have made all the necessary efforts to organize this workshop. I hope that your stay here in Addis Ababa will be pleasant and fruitfull for our region.

I declare that the "Training Workshop on Industrial Exploitation of Medicinal and Aromatic Plants in East Africa" is open.

I thank you,