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**UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION**

**REPORT OF THE  
TECHNICAL  
CONSULTATION  
ON PRODUCTION  
OF DRUGS  
FROM MEDICINAL PLANTS  
IN DEVELOPING  
COUNTRIES,**

**Lucknow, India,  
13-20 March 1978 .**

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*\*This was not one of the Consultations called for in paragraph 81 (d) of the Lima Declaration and Plan of Action and should not be confused with any of the "Consultation Meetings" organized by UNIDO in response to that call.*

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#### INTRODUCTION

At several UNIDO meetings on pharmaceuticals, the developing countries have expressed a strong wish for the promotion, development and production of drugs derived from medicinal plants, so as to enable them to utilize their own resources, economize on foreign exchange and become self-sufficient and self-reliant in that field of pharmaceuticals.

In pursuit of those aims, UNIDO organized a workshop, called the Technical Consultation on the Production of Drugs from Medicinal Plants in Developing Countries, under the joint auspices of UNIDO, the Government of India and the Central Drug Research Institute of India (CDRI), at Lucknow, India, from 13-20 March 1978. Background papers were prepared by UNIDO consultants and reviewed at UNIDO headquarters at Vienna. A paper prepared by the UNIDO secretariat provided the guidelines for the formulation of a plan of action for the sector. Experts from various countries were also requested to prepare country papers on the status of production and use of drugs from medicinal plants in their countries.

#### RECOMMENDATIONS

1. A number of essential drugs used in modern medicine can be produced from medicinal plants available in developing countries. Priority in the production of drugs derived from medicinal plants should be given to drugs that are well accepted and widely used (listed in annex I and III).
2. In the cultivation of medicinal plants, priority should be given to the plants identified by UNIDO.
3. Developing countries should be helped by UNIDO to start the production of products based on indigenously available/cultivated plants to meet demand within the country and also for export.
4. The technological status of different developing countries varies greatly; some countries have practically no industry and cannot easily obtain the solvents required for extraction, while others have a reasonably well established phytochemical industry. Countries in the first category could make a start by setting up units for the preparation of crude extracts for domestic use and for export. The production units should have well-equipped quality control laboratories attached to them. Even small units able to process one ton of raw material a day would be of economic benefit. (See annex IX for a description of such a unit.) Countries that already have a reasonably well established phytochemical industry could set up more sophisticated production plants. UNIDO should assist in the transfer of technology and supply of equipment, if required.
5. The training of personnel is important, and UNIDO should organize training programmes for individual countries or groups of countries on the cultivation of medicinal plants, the setting up of pilot plants and production units, the quality control of products, and pharmacological screening. One training centre could be located at Lucknow to take advantage of the facilities available at the Central Drug Research Institute of India and the Central Indian Medicinal plants Organization (CIMPO). Mobile units could also serve a useful purpose by training personnel directly within the country itself. The technical co-operation between Developing countries (TCDC) training programme could also be very useful, and UNIDO should make efforts to organize such programmes.

6. Developing countries that have a variety of important plants, for which there is a demand on the international market (see annex IV), should be assisted to process those plants into semi-finished form for export. Detailed market studies must be made, however, so as to avoid creating a glut on the market.
7. The use of pure active principles as medicaments may be discouraged wherever total extract can be used, depending on pharmacological evidence. The effect of this would be to bring down the price of the medicaments.
8. The foreign exchange budgets of some developing countries are limited and it is difficult for them to allocate funds for the establishment of production units that require foreign exchange. UNIDO should allocate funds for the least developed countries from its own resources, UNDP grants or outside donations for the purpose so as to accelerate the development of the medicinal plant industry.
9. UNIDO should prepare detailed techno-economic reports for small multi-purpose production units to process medicinal plants. The reports should cover sources of technology, the minimum economically viable plant size, raw materials required, equipment, investment, and markets.
10. UNIDO should establish an information centre for drugs derived from medicinal plants and should inform developing countries of progress made. This centre could be the National Information Centre for Drugs and Pharmaceuticals (NICDAP) already established at CDRI. Co-operating countries and UNIDO could send information to NICDAP, and the information could then be disseminated widely. (A description of NICDAP is in annex X.)
11. It would be useful if UNIDO could establish a budget for the purchase of technology for the production of drugs from medicinal plants and by synthesis, and could make the technology available to the developing countries interested in it.
12. UNIDO, through its chemical industry programme, should help to make available the solvents and materials needed for the production of pharmaceuticals so as to promote the local production of drugs.
13. One of the problems of an industry processing medicinal plants is to ensure a regular supply of such plants. Some of them grow wild, but many others need to be cultivated. UNIDO, in co-operation with FAO, could help by making arrangements for the supply of planting materials of the right quality, and

agro-technology, if required, although the help needed for promoting cultivation would have to be provided by the Government of each country. The developing countries might consider setting up a separate organization for promoting the cultivation of medicinal plants on the lines of CIMPO. Such an agency could make planting material available to the cultivators, and provide the agro-technological package and other inputs. It could also help in carrying out market surveys and buying the plants from the cultivators and supplying them to the appropriate agencies for production or export.

14. Developing countries have a rich flora that is a potential source of new drugs and new biologically active substances. A co-ordinated effort is needed to exploit that vast resource. Although each country should set up its own research laboratories for the biological evaluation of its own plants, UNIDO could help to co-ordinate the efforts. Some of the smaller countries may not be able to set up research laboratories for wide-range pharmacological screening. Such countries could start by making extracts, and use for screening the facilities of well-established institutions such as CDRI, the Instituto Mexicano para el Estudio de Plantas Medicinales, the Bangladesh Council of Scientific and Industrial Research Laboratories, and the Pakistan Government Institute of Chemistry.

15. The developing countries should be careful, when using their medicinal plant resources, not to disturb the ecological balance. They should take steps to conserve and preserve the germ plasma available and also their forest wealth. Many of those resources will be needed by the drug industry for many years to come.

16. Many of the developing countries have their own traditional systems of medicine, and large segments of their populations still depend upon traditional remedies. Efforts should be made to include traditional remedies in health care programmes in those countries. To that end:

(a) The production of established traditional remedies should be taken up by centralized agencies, with proper quality control of the product;

(b) In order to ensure the safety of drugs that are going to be used for long periods, studies should be made of their sub-acute and chronic toxicities;

(c) Remedies whose use is not yet well established should be subjected to direct clinical trials to establish their efficacy;

(d) For the scientific production of traditional remedies, proper practices must be established for the cultivation, storage, and processing of plants, and analyses of the medicaments made from them;



(e) Herbal remedies whose usefulness has been established by pharmacological, clinical and toxicological studies should, after approval by the Departments of Health of each country, be made part of medical college courses;

(f) Remedies for which claims need to be verified experimentally should be tried on animals in the form they are used in the traditional system of medicine;

(g) UNIDO should help to organize facilities for proper clinical evaluation, pharmacological screening and the development of technology in countries that lack such facilities.

17. An advisory board of five experts representing different aspects of the phytochemical industry should be constituted by UNIDO to evaluate the prospects for increasing the production of crude drugs, initially in South-East Asian countries, and subsequently in African and Latin American countries. The advisory board should also draw up a master plan for phytochemical research and development.

18. UNIDO should play a leading role in mobilizing the developing countries to produce drugs from medicinal plants and should take measures to accelerate the establishment of production units in those countries. The programme of technical co-operation between developing countries organized and financed by UNIDO can play an important part in the achievement of this objective. Such efforts would help developing countries with their expanded national health programmes, improve their economies and create employment opportunities.

Part one. Report of the meeting

I. ORGANIZATION OF THE MEETING

The Director and Chairman of the meeting was A. Tcheknavorian, Chemical Industries Section, Industrial Operations Division, UNIDO. Two meetings were held each day. The programme of activities included the following:

- Presentation and discussion of submitted technical and country papers
- Compilation of lists of medicinal plants
- Visits to establishments concerned with medicinal plants in Bangalore and Bombay
- Consideration and adoption of the final report and recommendations

The opening formalities of the meeting including an address by S. Krishnashramy, Secretary to the Government of India, Ministry of Chemicals and Fertilizers, who underlined the significance of medicinal plants in countries where modern medicines were often available to less than a quarter of the population.

II. SUMMARY OF DISCUSSION

A general discussion followed the presentation of papers. It was agreed that countries that grow medicinal plants should be encouraged to go ahead with the production of drugs that clinical evidence had shown to be effective. The group also agreed that the production level for each country would depend on its infrastructure, the plants it had available and the state of its technology. Developing countries were classified into three groups:

- (a) Those with no facilities for research and development, pilot plants or industrial production;
- (b) Those with facilities only for the preparation of extracts of medicinal plants;
- (c) Those with facilities for pilot plants or the industrial production of active principles from medicinal plants.

All participants were of the opinion that, although UNIDO should emphasise the need for the production of plant drugs used in both the traditional and the modern systems of medicine, it should give immediate attention to plant

products that were accepted in modern medicine, were widely used in health programmes or were of large economic value. UNIDO could assist the developing countries by making available technology, training personnel, and making market studies in collaboration with other United Nations agencies. It could also help with the design of plants, and in developing methods of quality control and standardization of products for local use and export. It was suggested that, in order to facilitate and accelerate the establishment of a pharmaceutical industry based on medicinal plants, the developing countries should be urged to co-operate with each other on the transfer of technology, the training of technical personnel and the supply of equipment and planting material. Countries that did not even produce total extracts of plants should be assisted in the setting up of production units to do so. Countries that wished to process extracts further and produce pure active principles but did not possess the necessary technology; might be helped by UNIDO to acquire it. It was pointed out that the production processes for most of the important plant products were not covered by patents; so patents would not be a barrier to production. It was the general opinion that medicinal plants for which there was an international demand should not be exported by the producing country in the form of raw plant material, but could be processed further. The export of a semi-finished product would give the benefit of added value and would create additional employment opportunities in small industry. However, the export of plants and plant products would need to be organized so as not to create a glut on the market. A detailed techno-economic and market study should therefore be carried out to assess real market requirements.

It was pointed out that an industry for the production of drugs from medicinal plants, whether for local use or for export, could be successful only if the quality of the products conformed to specifications. A well-equipped quality control laboratory was, therefore a basic requirement for a production unit. Adequate quantities of good quality raw materials must also be available; so the cultivation, collection and storage of plant materials would have to be organized before production units were established. As regards the cultivation and availability of plant material, it was suggested that UNIDO, in co-operation with FAO and the agriculture and forest departments of each country, might carry out studies to establish the most appropriate methods of cultivation of important medicinal plants, estimate the availability

of plant material, and determine the most suitable soil and climatic conditions for the cultivation of various plants in different regions. The success of the mobile unit mission organized by UNIDO for the production and quality control of extracts of medicinal plants in Africa and Asia had confirmed that such missions were an appropriate means of transferring technology for the production of extracts and training personnel in production and control methods in countries without experience in them. The investment in such a mobile unit, which could be taken to remote areas where the plants were grown, was estimated to be about \$US 80,000.

#### Control of production of opium

It was suggested that, in view of the abuse of opium, the production of morphine and codeine from poppy capsules and straw should be promoted, and the preparation of opium be discouraged and put under stricter control. Simultaneously, efforts should be made to suggest alternative crops for opium poppy cultivators and to develop new substitutes for morphine and codeine.

#### Joint pricing policy for medicinal plants

To ensure the continued cultivation of medicinal plants in the developing countries, the prices should be remunerative for the farmer. Participants expressed the opinion that UNIDO should therefore encourage the establishment of international agencies that would buy the raw plant material from the individual countries and prevent unhealthy competition between grower countries.

#### Establishment of regional research and development centres

The establishment of research and development facilities was expensive and required skilled personnel, and might be beyond the immediate capacity of individual developing countries. It was therefore suggested that use should be made of existing research and development centres in the regions, strengthening them, where necessary, so as to enable them to cater to regional needs until national facilities could be established. The centres could concentrate on the screening of plants for therapeutic groups for which plant drugs were not available and also on the development of plant cultivation and processing technology. (For a list of some of the centres see annex VII.)

### Availability of planting material

In order to promote the cultivation of medicinal plants, it was necessary to make available suitable planting materials that some countries had difficulty in obtaining. Participants felt that UNIDO could play an active role in that area.

### Manufacturing technology

A UNIDO secretariat paper on the technology of the manufacture of drugs from plants outlined the various extraction methods that could be used. The representative of the UNIDO secretariat said that, in order to make a comprehensive plan based on important plants identified at the Meeting, arrangements would be made for the preparation of detailed reports on technical and other matters, including equipment, source of technology, raw materials required, the economic unit for production, the investment cost of production, and market potential.

A model unit for the preparation of crude extracts is shown in annex IX.

### III. COMPILATION OF LISTS OF MEDICINAL PLANTS

The primary objective of UNIDO in organizing the Meeting was to identify essential drugs derived from medicinal plants that are widely used and for the production of which technology is available. In order to achieve that objective, the following lists were compiled:

(a) A list of the medicinal plants found in various regions (Africa, Asia and Latin America) whose active principles are used in modern medicine (annex I), and an additional list of plants used mainly in traditional medicine in Africa, Asia and Latin America (annex II);

(b) A more restricted list of the plants that are more widely used for the production of medicines, classified by therapeutic group (the WHO essential drug list was used as a guide) (annex III);

(c) A list of plants that are not necessarily used as drugs but are the source of products used in the pharmaceutical industry and for which there is a demand on the international market (annex IV). Such plants should be cultivated and processed into semi-finished form for export;

(d) A list of plants on which research and development is well advanced in various countries and that are likely to be introduced into clinical practice (annex V);

(e) A list of commonly used excipients (annex VI).

In order to promote the production of finished formulations from active principles, and to keep their price within the reach of ordinary people, steps should be taken to make the excipients used in the formulation available at reasonable prices. To keep the cost of treatment low, total extracts can be used in place of pure active principles in most cases, if pharmacological evidence indicates that it is possible to do so.

As the use of traditional medicines is quite widespread in most of the developing countries, particularly in rural areas, there is a need to evaluate their safety and ensure quality-control standards of the products at every stage, including cultivation, storage and handling of the plants. Modern scientific inputs are therefore needed.

In the light of the foregoing, steps should be taken to encourage the developing countries to produce and use drugs derived from medicinal plants. To do so would have the following advantages:

- (a) The foreign exchange required to import such drugs would be saved;
- (b) The export of raw plant material would be discouraged, and the export of processed products encouraged, which would earn more foreign exchange;
- (c) More effective use would be made of the knowledge of traditional systems of medicine that already cater to large segments of the population in developing countries;
- (d) Natural vegetable resources would be utilized;
- (e) Industrialization would be promoted;
- (f) The appropriate technology for the developing country would be developed;
- (g) Farmers' income would be augmented.

Part two. Summaries of technical papers\*

An integrated approach to research on medicinal plants

N. Anand

Large sections of the population of the developing countries still depend on traditional systems of medicine, the cost of which is relatively low. Traditional remedies should therefore be included in the health care programmes of those countries. The measures needed to do that are: (a) standardisation of the production and quality control of important medicaments, (b) evaluation of the safety of drugs that have to be administered for long periods, (c) direct clinical evaluation of less commonly used drugs, and (d) broad-spectrum biological screening of drugs or plants for which the evidence as to their therapeutic activity is insufficient or doubtful.

Since plants are an important renewable source of drug intermediates and other chemicals of economic value, their cultivation, and production of their active constituents, would be of great benefit to the developing countries and should be promoted. About twenty such plants have been identified.

Medicinal plants for curing diseases other than communicable tropical and infectious

F. Sandberg

The paper discusses the origin, therapeutic use, and form of application of each of a number of plants, together with their market prospects and the technology for processing them.

Plants of the African pharmacopoeias used in the treatment of tropical diseases

J. Kerharo

Many tropical diseases belong to well established nosological groups. The classification adopted, in accordance with tropical pathology data, therefore reviews in order the treatment of ailments due to protozoan helminths,

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\*The titles of those with documents symbols are listed in annex VIII.

spirochaetes, viruses, microbes, and deficiencies, and the treatment of miscellaneous ailments. The therapeutic indications and uses of 159 plants are given. A number of varieties already used in modern medicine or meriting priority attention are singled out:

<u>Plant</u>	<u>Disease used against</u>
<u>Cucurbita maxima</u> } <u>Cucurbita pepo</u> }	Taeniasis
<u>Chenopodium ambrosoides</u>	Helminthiasis Nematodiasis
<u>Euphorbia hirta</u>	Amoebiasis Asthma
<u>Holarrhena floribunda</u>	Amoebiasis Trichonemiasis
<u>Strophanthus sarmentosus</u>	Trachoma
<u>Caloncoba echinata</u> } <u>Caloncoba welwitschii</u> } <u>Centella asiatica</u> }	Leprosy Dermatitis
<u>Fagara santhoxyloides</u>	Drepanocytosis
<u>Guiera senegalensis</u>	Choleraform diarrhea

The paper concludes with the suggestion that the development of appropriate pharmaceutical technology based on the use of local drugs could improve the well-being of the people of developing countries that are short of medicaments.

#### Industrial requirements for processing medicinal plants

E. Bombardelli

A survey of the main technologies for the preparation of natural products of vegetable origin is preceded by some considerations of the current situation and general market trends. The most important phases of the preparation of any product, whether extract or pure compound, are examined, from drug grinding to the final phases of purification. The choice of solvent and the type of extractor to be used depends on the technical information of the most important plants. A typical scheme for processing and a few examples of preparation of some extracts illustrate the technology involved.



Drugs derived from medicinal plants

Secretariat of the United Nations Industrial Development Organisation

The paper stresses the importance of the production and use of drugs derived from medicinal plants in the developing countries and the role played by UNIDO in this field. UNIDO feasibility studies on medicinal plants, in several developing countries show that the lack of organization for the cultivation and collection of the plants, transport, suitable technology, market information, financial resources, skilled personnel, and research facilities hinder the commercial exploitation of medicinal plants. In order to encourage co-operation between developing countries, UNIDO has developed regional projects in countries of the Sahara, South-East Africa and Asia. It also organized mobile units in Africa in 1977 for extraction, distillation, and process control and testing. A mobile unit mission is being organized for Asia in 1978.

Part three. Summaries of country and other papers

Algeria

Algeria, because of its geophysical and climatic conditions, has more than 500 varieties of medicinal plant. More than half are used in traditional medicine; many are aromatic plants that are of interest to the perfume industry. Scientific studies should be made of plants that are regularly used in traditional medicine, and also of related varieties already used in the pharmaceutical industry, so as to establish their properties before their use is promoted.

Burma

In Burma, the development of plant materials as a source of medicines and the promotion of drugs from medicinal plants for national health care are approached in the following manner.

First and foremost, the relevant departments were organized with an overall authority to co-ordinate their activities. The Burmese Central Research Organization, which was formed to identify and test-cultivate medicinal plants has identified 700 medicinal plants during the 20 years of its existence.

The Burma Medical Research Institute is concerned with the biological screening and pharmacological testing of medicinal plants and indigenous medicines. Here, care is taken to differentiate between the principles and methodology of modern and traditional medicines.

An organization under the industries department is responsible for medicinal plant cultivation. Much pioneering work, such as extension services and incentive schemes for farmers, is necessary. Choice of the right type of species, soil and climatic conditions is also essential.

The state pharmaceutical industry has facilities for the extraction and formulation of galenicals. Various hospital pharmacies under the public health department are capable of compounding and formulating indigenous drugs. Though quality control can be exercised for modern herbal drugs, the same does not apply to traditional drugs as yet, as the use of complex mixtures makes standardization difficult.

The various indigenous medical clinics stationed throughout the country provide appropriate channels for the distribution of official traditional drugs, although there are many privately manufactured drugs that remain to be examined. Some of these have been tested by the National Health Laboratory and found to be free of toxic effects.

Last but not least is the medical education system. In 1970 an Institute of Indigenous Medicine was established with the aim of producing qualified traditional practitioners who can prescribe traditional drugs to patients with more confidence.

#### Cuba

Cuba possesses an abundant medicinal flora, and numerous plants are in use at present.

The Experimental Station of Medicinal Plants was established in 1973 to study the cultivation conditions of the plants and also their botanical and genetic characteristics.

#### India

As a result of research and development carried out during the last 25 years, India has developed a prosperous medicinal plants industry. At present, India produces substantial quantities of crude drugs and active constituents and is one of the leading exporters of crude drugs and active constituents from plants. Medicinal plants produced in India are either collected from wild sources or cultivated in various parts of the country. The paper lists some of the most important plants that are collected from the forests or cultivated, and other that are being cultivated on an experimental scale.

Research on the use of tissue culture for the propagation of medicinal plants included work on Dioscorea sp., Solanum sp., Costus, Rauwolfia serpentina and Atropa belladonna. The work was taken up to the pilot-plant stage. Significant results were obtained with simple ingredients. A scheme is being devised to extend the work to commercial cultivation.

#### Madagascar

In view of Madagascar's rich and varied flora, it is not surprising that the traditional pharmacopoeia should have been taken as the basis for research

to find new medicaments. A number of active principles have been isolated since the 1950s. The National Pharmaceutical Research Centre has been set up to review the pharmacopoeia and it is hoped that many other plants will be used by the pharmaceuticals industry.

#### Mexico

The Mexican Institute for the Study of Medicinal Plants (IMEPLAM) suggests that there should be an international data bank on medicinal plants to gather ethnobotanical, historical and anthropological information. Lists of plants cultivated should be exchanged by medicinal plant institutions in developing countries.

Pharmacological testing should establish the strategy for any chemical work.

Work should be done on plants for which there is ethnobotanical, historical and anthropological information, in preference to plants for which there is no background information.

#### Nepal

Many kinds of important herbal plants grow in the tropical, subtropical, temperate and alpine regions of Nepal, which exports plants worth over 20 million rupees (\$US 1.6 million) a year all over the world. Besides 82 Ayurvedic Centres, there are 65 health posts where modern medicines are stocked. Fifteen Ayurvedic preparations are dispensed to combat common diseases. The author gives a list of 62 medicinal plants used in Ayurvedic preparations and included in other pharmacopoeias. The department of medicinal plants, which is a research organization, is responsible for the botanical survey and herbarium, herbal forms, the royal botanical garden, and the royal drug research laboratory.

Research is needed on traditional medicines, such as "silajit" for curing infective hepatitis, to obtain the effects desired.

#### Pakistan

The main obstacles to the wider cultivation and greater use of medicinal plants in Pakistan and other developing countries are:

- (a) The lack of information on future international demand for various medicinal plants;
- (b) The lack of feasibility studies and long-term forecasts based on current international prices and future development trends;

(c) The lack of detailed information about optimum conditions of growth (soil conditions; optimum time of planting and harvesting; fertilizers, insecticides and fungicides required; the most suitable monitoring procedures for assaying the percentage of active constituents at various stages of growth;

(d) The lack of knowledge of the most feasible processing technology for the isolation and separation of active constituents on various scales.

The integration of traditional systems of medicine and modern medical practices can be brought about by authenticating each herbal prescription after pharmacological, clinical and toxicological studies and including information about useful and authenticated herbal remedies in the courses of various medical colleges.

#### Rwanda

The research in laboratories in Rwanda follows a rational path: ethnobotanical screening, phytochemical screening, pharmacological screening, toxicological screening, and the production of drugs. Local plants listed in the various pharmacopoeias, are studied first, then plants listed in the various pharmacopoeias but of different species, and finally plants used in native medicine but not listed. The author lists the plants currently used in the production of drugs.

#### Thailand

There are 1,066 traditional drug factories and 177 modern drug factories in Thailand. About 90 per cent of the raw materials used for traditional drugs are obtained from medicinal plants, and more than 90 per cent of the raw materials used in modern drug factories are imported. The annual consumer value of drugs on the market is estimated to be \$US 200 million. The annual export value f.o.b. of medicinal plants from Thailand is between \$US 1 million and \$US 3 million and is increasing.

Since 1940, research on indigenous medicinal plants had been done by various institutes, but was initially mostly of academic interest. By 1965, the Applied Scientific Research Corporation of Thailand (ASRCT), with financial support from the Thai Government and aid from UNIDO, succeeded in establishing a co-operative research programme on medicinal plants, with the aim of developing modern drugs from indigenous medicinal plants.

The co-operating bodies, comprising various institutes with different background experience, were able to provide the necessary project approach. Work was done on pharmacognosy, pharmacology and toxicology, chemical identification, clinical study, drug formulation, economic evaluation, and cultivation.

Other papers

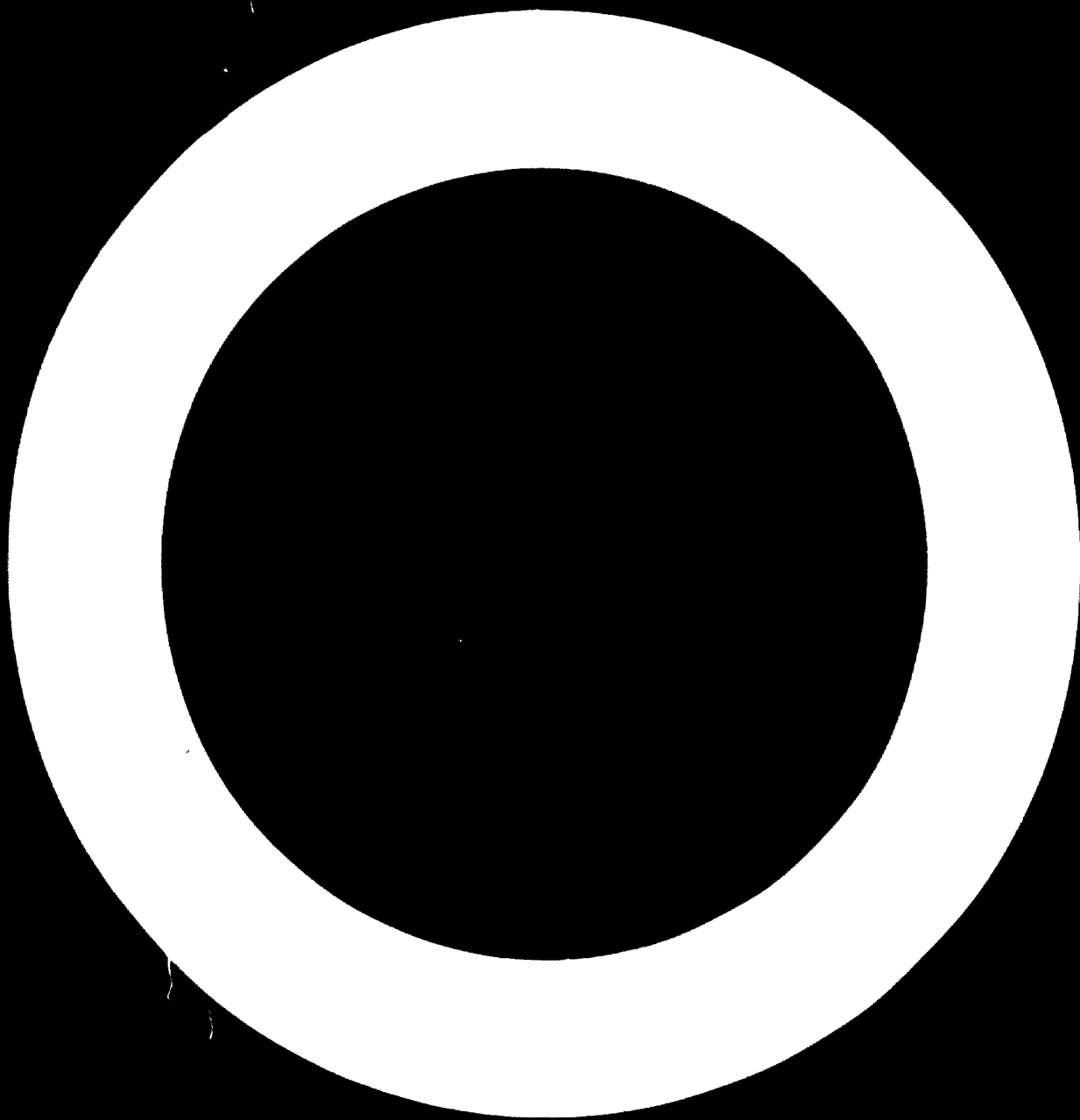
Research on medicinal plants in Central and Equatorial Africa

In 1965, 196 species of medicinal plant were identified. Research work on those plants included pharmacological screening of the whole material, crude extract and specific fractions. Pronounced strong activity was shown by 129 of the plants. Work also was carried out to isolate and elucidate the molecular structure of the compounds.

UNCTAD

Assistance by ITC/UNCTAD/GATT in the establishment of a programme for medicinal plants and their derivatives could be of great value, mainly for ascertaining market demand but also for elaborating marketing strategies and development plans.

Integrated programmes involving co-operation with other international bodies, promotional actions and the establishment of contacts, would help the developing countries to formulate production plans that would make it possible to meet domestic demand for some basic medicines and expand export trade.



Annex I

BIOLOGICALLY ACTIVE PLANTS CONSIDERED DURING THE TECHNICAL CONSULTATION

Name of plant	Part of the plant used	Product	Availability		Region			Method of production <sup>a/</sup>	Market potential		Trend
			Culti- vated	Wild	Africa	Latin America	Asia		Local	Export	
<u>Acacia arabica</u> <u>Acacia senegal</u>	Stem	Gum		+	+				+	++	Steady
<u>Aconitum sp.</u>	Root	Total extract		+			+	C	+	+	Down
<u>Accurc calamus</u>	Rhizome	Essential oil and crude drug		+			+	A	+	++	Steady
<u>Aesculus hippocastanum</u>	Seeds	Aescin and total extract	+	+			+	C	+	++	Up
<u>Aloe sisalana</u>	Juice	Hecogenin	+		+	+	+	D	+	++	Steady
<u>Aloe sp.</u>	Leaf juice	Aloin	+	+	+	+	-		+	++	Steady
<u>Ami majus</u>	Seeds	Xanthotoxin	+	+	+	+	+	D	+	++	Up
<u>Ami visnaga</u>	Fruits	Visnagin, khellin		+	+	+		C	+	++	Steady
<u>Anomum subulatum</u>	Fruits	Essential oil	+	+	+		+	A	+	++	Up
<u>Anomum xanthioides</u>	Fruits	Essential oil	+	+	+		+	A	+	++	Up
<u>Andira araroba</u>	Stem wood	Total extract		+	+	+		C		+	Steady
<u>Anethum sp.</u>	Fruit	Essential oil	+			+	+	A	+	+	Steady
<u>Anise</u>	Fruits	Essential oil	+		+		+	A	++	++	Steady
<u>Artemisia maritima</u>	Flowering tops	Santonin		+	+		+	D	+	+	Steady
<u>Atropa belladonna</u>	Leaf and roots	Total alkaloids	+				+	C	++	++	Steady
<u>Berberis aristata</u>	Root, stem bark	Berberine		+			+	B	+	++	Steady
<u>Berberis asiatica</u>	Root, stem bark	Berberine		+			+	B	+	++	Steady
<u>Berberis lycium</u>	Root, stem bark	Berberine		+			+	B	+	++	Steady
<u>Betula alnoidea</u>	Stem bark	Crude drug		+			+		+	+	Steady
<u>Capaicum annum</u>	Fruits	Capaicin oleoresin	+		+	+	+	D	+	+	Steady
<u>Carica papaya</u>	Fruit juice	Papain	+		+	+	+	B,C	+	+	Up
<u>Carum carvi</u>	Fruit	Essential oil	+		+		+	A	+	++	Steady
<u>Cassia acutifolia</u>	Leaves and pods	Sennosidee		+	+	+	+	C	+	++	Up
<u>Cassia angustifolia</u>	Leaves and pods	Sennosidee	+				+	C	+	++	Up
<u>Cassia italica</u>	Leaves and pods	Sennosidee		+	+			C	+		
<u>Catharanthus roseus</u>	Leaves and roots	Vinblastine, vincristine, rebaucine	+	+	+	+	+	D	+	++	Steady
<u>Centella asiatica</u>	Whole plant	Asiaticoside	+	+	+		+	C	+	++	Steady
<u>Centella scuminata</u>	Roots	Emetine		+		+	+	D	+	++	Up
<u>Cephaelis ipecacuanha</u>	Roots	Emetine	+			+	+	D	+	++	Up
<u>Ceratonis siliqua</u>	Fruit	Total extract	+	+	+			C	+	++	Steady
<u>Chenopodium ambrosioides</u>	Flowering top and whole plant	Essential oil	+	+	+	+	+	A	+		Steady
<u>Cinchona sp.</u>	Stem and root bark	Quinine, quinidine		+	+	+	+	D	++	++	Up
<u>Claviceps purpurea</u>		Ergotamine, ergotoxins, ergometrine	+			+	+	D	++	++	Steady
<u>Cola nitida</u>	Seeds	Total extract	+	+	+	+		B	++	++	Up
<u>Combretum micranthum</u>	Leaves	Total extract		+	+		+	C	+	++	Up

<sup>a/</sup> A = steam distillation; B = water extraction; C = Alcohol extraction; D = extraction with other solvents.



Annex I (Cont'd)

Name of plant	Part of the plant used	Product	Availability		Region			Method of production a/	Market potential		Trend
			Culti- vated	Wild	Africa	Latin America	Asia		Local	Export	
<u>Commiphora mukul</u>	Resin	Gum		+			+	D	++		
<u>Costus speciosus</u> <u>Costus citratus</u>	Rhizome	Diosgenin		+		+	+	D			
<u>Cymbopogon flexuosus</u>	Leaves	Essential oil, citral	+		+	+	+	A	+	++	Steady
<u>Datura sp.</u>	Leaves	Atropine									
<u>Derris elliptica</u>	Root	Rotenone	+	+	+		+	D	+	++	Up
<u>Digitalis lanata</u>	Leaves	Digoxin and lanatosides	+		+			C,D	++	++	Steady
<u>Dioscorea sp.</u> <u>Dioscorea leichartii</u>	Tubers	Diosgenin	+	+	+	+	+	B	++	++	Steady
<u>Duboisia myosoroides</u>	Stem	Hyoscyamine, hyoscyne	+	+	+	+	+	B	++	++	Steady
<u>Ephedra Gerardiana</u>	Whole plant	l-Ephedrine		+			+	D	++	++	Steady
<u>Ephedra vulgaris</u>	Whole plant	l-Ephedrine		+			+	D	++	++	Steady
<u>Ephedra abrodensis</u>	Whole plant	l-Ephedrine		+			+	D	++	++	Steady
<u>Eucalyptus globulus</u>	Leaves	Essential oil	+		+	+	+	A	++	++	Steady
<u>Glaucoma flavum</u>	Leaves	Glauicine		+	+		+	C	++	++	Steady
<u>Glaucoma simplex</u>	Rhizome	Colchicine		+	+		+	B	++		Steady
<u>Gloriosa superba</u>	Rhizome	Colchicine		+	+		+	B	++	+	Steady
<u>Glycyrrhiza</u>	Rhizome	Total extract		+			+	B	++	++	Steady
<u>Heracleum candicans</u>	Roots	Xanthotoxin		+	+		+	D	+	++	Steady
<u>Hibiscus sabdariffa</u>	Flower	Dried flowers	+		+	+	+		+	++	Up
<u>Holarrhena floribunda</u>	Stem bark	Conoscyne and total alkaloid	+	+			+	D	+		
<u>Hrdnecarpus burali</u>	Seeds	Fixed oil, hydrocarpic acid		+			+		+		
<u>Hrdnecarpus rickiana</u>	Seeds	Chaulmoogric acid									
<u>Hyoscyamus sp.</u>	Root	Hyoscyamine and other alkaloids		+	+				+		
<u>Linnaea cathartica</u>	Whole plant	Camphor and essential oil		+	+			A	+	+	Steady
<u>Lobelia sarracidalis</u>	Leaf, flowering top	Lobeline and total extract		+			+	B	+		
<u>Mentha sp. (Japanese mint)</u> <u>Mentha piperita</u>	Whole plant	Essential oil	+		+	+	+	A	++	++	Up
<u>Mucuna pruriens</u>	Beans	l-Dopa	+	+	+	+	+	B	+	+	Steady
<u>Ocoba echinata</u>	Seeds	Fixed oil			+				+		
<u>Papaver somniferum</u>	Capsule and latex	Morphine, codeine, noscapine, papaverine	+				+	D	++	++	Up
<u>Paspiflora sp.</u>	Whole plant	Total extract	+	+	+	+	+	C	+	+	Steady
<u>Pausinystalia yohimbe</u>	Stem bark	Yohimbine and total extract		+	+			B	+	+	Steady
<u>Physostigma venenosum</u>	Seeds	Physostigmine, stigmastanol		+	+			D	+	++	Steady
<u>Pharacochlaine brevis</u>								C,D			
<u>Pilocarpus sp.</u>	Leaves	Pilocarpine		+		+		B	+	+	Steady

Annex I (Cont'd)

Name of plant	Part of the plant used	Product	Availability		Region			Method of production a/	Market potential		Trend	
			Culti- vated	Wild	Africa	Latin America	Asia		Local	Export		
<u>Plantago ovata</u>	Seeds, husks	Ispaghula, psyllium	+					+	++	++	Up	
<u>Podophyllum hexandrum (P. emodi)</u>	Tubers	Podophyllin, podophyllotoxin		+				+	D	+	++	
<u>Polygala senega</u>	Roots	Resin		+	+					+	+	Up
<u>Prunus africana</u>	Stem bark	Total extract		+	+				C	+	++	Steady
<u>Psoralea corylifolia</u>	Seeds	Psoralen		+				+	D	+	+	Steady
<u>Rauwolfia heterophylla</u> <u>Rauwolfia serpentina</u> <u>Rauwolfia vomitoria</u>	Roots	Reserpine, ajmaline, deserpidine, rescinnamine, reserpiline		+	+				D	+	+	Up
<u>Rhus purshiana</u>	Bark	Crude extract		+		+			C	+	+	Steady
<u>Rhus emodi</u>	Rhizome	Total extract	+	+	+		+		C	+	+	Steady
<u>Rhus palmatum</u>	Rhizome	Total extract	+	+	+		+		C	+	+	Steady
<u>Ricinus communis</u>	Seeds	Fixed oil	+	+	+	+	+			+	++	Steady
<u>Solanum sp.</u>	Berries	Solasodine	+	+	+	+	+		D	+	+	
<u>Stemodia setigera</u>	Bark exudate	Gum		+	+		+			+	+	Steady
<u>Strophanthus gratus</u>	Seeds	Strophanthine, strophanthidine		+	+				D	+	+	Up
<u>Strophanthus komba</u>												
<u>Strychnos nuxvomica</u>	Seeds	Strychnine		+	+		+		D	+	+	Steady
<u>Tabernaemontana iboga</u>	Stem bark	Ibogaine		+	+				D		+	
<u>Taraxacum officinale</u>	Root	Resin and total extract		+		+	+		D	+	+	Steady
<u>Thevetia nerifolia</u>	Seeds	Peruvoside	+		+	+	+		D	+	+	Steady
<u>Urginea indica</u> <u>Urginea scilla</u>	Bulbs	Proscillaridine		+	+		+		C	+	+	Steady
<u>Valeriana officinalis</u> <u>Valeriana wallichii</u>	Rhizome	Total extract	+	+		+	+		C	+	+	Steady
<u>Yucca thursii</u> <u>Yucca africana</u>	Seed	Tabersonine		+	+				D		+	Up
<u>Vinca minor</u>	Leaves	Vincamine	+	+	+	+	+		D	+	+	Up

Annex II

ADDITIONAL LIST OF PLANTS USED MAINLY IN TRADITIONAL MEDICINE IN  
AFRICA, ASIA AND LATIN AMERICA

<u>Name of plant</u>	<u>Part of plant used</u>	<u>Type or use of drug</u>
<u>Acacia catechu</u>		For ulcers, boils, indigestion and throat pain
<u>Acacia senegal</u>	Gum	In diarrhoea
<u>Acconitum heterophyllum</u>		Antiperiodic, antidiarrhoeal, antirheumatic
<u>Achyranthus aspera</u>		In leprosy
<u>Acorus calamus</u>		Antispasmodic, carminative, antitussive
<u>Adansonia digitata</u>		Antidiarrhoeal
<u>Adhatoda vasica</u>		Antitussive
<u>Adonsonia digitata</u>		
<u>Aegle marmelos</u>		Antipyretic, stomachic, antidiarrhoeal
<u>Alchornea cordifolia</u>		Antimalarial
<u>Allium sativum</u>	Bulb	Anti-infectious
<u>Aloe barbadensis</u>		
<u>Alpinia galanga</u>	Rhizome	Anti-infectious
<u>Alpinia siamensis</u>	Rhizome	Anti-infectious
<u>Alstonia scholaris</u>		Antimalarial, febrifugal, antidiarrhoeal
<u>Althoea officinalis</u>		Antidiarrhoeal, antidyenteric
<u>Anonum xanthoides</u>		For tincture of cardamom, antitussive
<u>Anacardium occidentale</u>	Bark	Antidyenteric
<u>Andrographis paniculata</u>	Plant	Antidyenteric
<u>Anisomeles ovata</u>		Carminative
<u>Annona muricata</u>		
<u>Areca catechu</u>	Seed	Anti-infectious
<u>Artemisia abrotium</u>	Flower	
<u>Artemisia herbealba</u>		
<u>Asiacuosi asu</u>		Antimalarial

<u>Name of plant</u>	<u>Part of plant used</u>	<u>Type or use of drug</u>
<u>Asiacuosi deo asfams moris</u> (fresh)		Anthelmintic
<u>Asparagus racemosus</u>	Root	Antidysenteric
<u>Asparagus racemosus</u>		Refrigerant, diuretic, antidiarrhoeal
<u>Atrocarpus lakolcha</u>	Bark	Anthelmintic
<u>Averrhoa carambola</u>	Flower	Anthelmintic
<u>Azadirachta indica</u>	Bark	Antimalarial
<u>Azadirachta indica</u>	Oil	Antiseptic; in rheumatism
<u>Baliospermum montanum</u>		Antifilarial
<u>Bauhinia malabarica</u>	Plant	Antidysenteric
<u>Bergenia ligulata</u>		In fever, diarrhoea and pulmonary infection
<u>Berberis aristata</u> )		
<u>Berberis asiatica</u> }		In diarrhoea and jaundice
<u>Bidens fulosa</u>		
<u>Bidens pilosa</u>		Antimicrobial
<u>Blumea balsamifera</u>		As camphor
<u>Boerhavia diffusa</u>		Hypertensive, antidiuretic
<u>Boerhavia diffusa</u>		In uterine bleeding
<u>Butea frondosa</u>		Anthelmintic
<u>Carrophyllus aromaticus</u>		For toothache; carminative
<u>Carthamus tinctorius</u>	Flowers	Stimulant
<u>Carum copticum</u> (Ajowan)	Fruit	Stomachic, carminative
<u>Cassia tistula</u>		Laxative
<u>Catharanthus roseus</u>		
<u>Celosia argentea</u>	Seed	Anthelmintic
<u>Centella asiatica</u>		In skin diseases
<u>Cephaelis ipecachuana</u>		In amoebiasis
<u>Chenopodium ambrosiodes</u>		Bilassia
<u>Cimicifuga racemosa</u>		
<u>Cinnamomum ceylanicum</u>	Fruit	Anthelmintic
<u>Cinchona sp.</u>		Antimalarial

<u>Name of plant</u>	<u>Part of plant used</u>	<u>Type or use of drug</u>
<u>Cinnamomum camphora</u>		For rheumatism
<u>Cinnamomum inuctum</u>	Leaf oil	Antidiarrhoeal
<u>Cinnamomum tamala</u>	Bark	Aromatic, stomachic
<u>Citrus aurantifolia</u>	Root	Antidysenteric
<u>Cleomechlidonii</u>	Root	Anthelmintic
Clove		Carminative, stomachic
<u>Coleus kilimanoschari</u>		Antimicrobial
<u>Coptis tecta</u>	Rhizome	Tonic, antidiarrhoeal, ophthalmic
<u>Cucurbita pepo</u>	Seeds	Anthelmintic
<u>Curculigo orchioides</u>		For asthma, gonorrhoea; as diuretic and tonic
<u>Curcuma ocosa</u>	Rhizome	Blood circulation regulator
<u>Cyperus rotundus</u>	Bulb	Anti-infectious
<u>Cyperus scariosus</u>		Antidiarrhoeal, anti-inflammatory
<u>Datura foetida</u>		
<u>Datura stramonium</u>		
<u>Derris pinnatus</u>		Antimalarial
<u>Desmodium gangeticum</u>	Root	Astringent, tonic
<u>Desmodium triflorum</u>	Plant	
<u>Dipterocarpus tuberculatus</u>	Resin	For ulcers
<u>Abelia ribes</u>		Anthelmintic
<u>Ephedra gerardiana</u>		Antiasthmatic; for inflammation of bronchi
<u>Eugenia cumini</u>	Bark	} Antidysenteric
<u>Eugenia jambos</u>	Seed	
<u>Eugenia malaccensis</u>	Bark	
<u>Eupatorium odoratum</u>	Herb	Haemostatic
<u>Euphorbia thymifolia</u>		Antidysenteric
<u>Ferula foetida</u>		For gastric disorders

<u>Name of plant</u>	<u>Part of plant used</u>	<u>Type or use of drug</u>
<u>Garcinia pedunculata</u>	Dried fruit	For indigestion
<u>Gentiana kurroo</u>	Rhizome	Bitter tonic
<u>Gentiana sp.</u>		Antipyretic
<u>Glycyrrhiza glabra</u>		Colitis
<u>Grematophyllum speciosum</u>	Bulb	Anthelmintic
<u>Hagenia abyssinica</u> ( <u>Taenia, Botigocephalus</u> )		For ophthalmic disorders of children
<u>Heliotropium indicum</u>	Herb	For ulcers; diuretic
<u>Holarrhena antidysenterica</u>	Bark	Antidysenteric
<u>Iboza riparia</u>		Antimicrobial, antimalarial vermifuge
<u>Iris nepalensis</u>		Diuretic, in bilious obstruction
<u>Ixora coccinea</u>	Root	Anti-infectious
<u>Juniperus sp.</u>	Fruit	
<u>Lansium domesticum</u>	Seed	Anthelmintic
<u>Linaria remosissima</u>		Antimalarial
<u>Lobelia pyramidalis</u>		Antispasmodic
<u>Mallotus philippinensis</u>		Anthelmintic
<u>Matricaria chamomilla</u>		
<u>Melia azadirach</u>	Leaves	Anthelmintic
<u>Mentha citrata</u>		
<u>Mesua ferrea</u>		Stomachic, expectorant, paste for bites
<u>Millingtonia hortensis</u>		For hypertension
<u>Nimosa pudica</u>	Leaves, roots	For haemorrhoids
<u>Nirabilis jalapa</u>		Wound dressing
<u>Momordica charantia</u>		Hypoglycemic
<u>Murraya paniculata</u>	Leaves	Anthelmintic
Mustard		Oil for massage and ointments
<u>Myristica fragrans</u>		Carminative; for nausea and vomiting

<u>Name of plant</u>	<u>Part of plant used</u>	<u>Type or use of drug</u>
<u>Nardostachys jatamansi</u>		Carminative; for cholera and hysteria
Nutmeg		Carminative, stomachic
<u>Ocimum basilicum</u>		Antidysenteric
<u>Ocimum sanctum</u>		Hypoglycemic, expectorant
<u>Occhis lanata</u>		Tonic
<u>Pandanus odorus</u>	Leaves (fresh)	Anti-infectious
<u>Perezia cuernavacana</u>	Roots	Antitumoral
<u>Phyllanthus emblica</u>		Refrigerant, diuretic and laxative
<u>Phyllanthus madraspatensis</u>		Antidysenteric
<u>Picrorhiza scrophulariaefolia</u>		Antipyretic, stomachic
<u>Pinus</u> sp.	Resin	Carminative, expectorant; in asthma and bronchitis
<u>Piper betle</u>	Leaves	Anti-infectious
<u>Piper nigrum</u>		Stomachic, antitussive
<u>Piper longum</u>		Antifilarial, antipyretic
<u>Piper longum</u>	Rhizome	Stimulant, tonic
<u>Plantago major</u>		Antidysenteric
<u>Plumbago rosea</u>	Root	Stimulant in rheumatism
<u>Plumbago zeylanica</u>		Antifilarial
<u>Podophyllum hexandrum</u>		For liver and gall bladder
<u>Portulaca oleracea</u>	Leaves	Anti-infectious
<u>Pousolzia pentandra</u>	Leaves	Anti-infectious
<u>Punica granatum</u>	Fruit	Anti-infectious
<u>Quisqualis indica</u>	Seed	Anthelmintic
<u>Rauwolfia serpentina</u>		Hypnotic, sedative, hypertensive
<u>Rheum emodi</u>		Purgative; in diarrhoea
<u>Rhus vulgaris</u>		Hemionoides
<u>Rubia cordifolia</u>		For leprosy

<u>Name of plant</u>	<u>Part of plant used</u>	<u>Type or use of drug</u>
<u>Sapindus mukrolli</u>		Spermicidal
<u>Securidace longipedunculata</u>		Molluscicidal
<u>Securinega virosa</u>		Polyvalent
<u>Smilax peguana</u>	Rhizome	Antisymphilitic
<u>Stemona collinsae</u>	Plant	Anthelmintic
<u>Stemona curticii</u>		
<u>Stemona minor</u>		
<u>Stemona tuberosa</u>		
<u>Streblus asper</u>	Seed, bark	Anti-infectious
<u>Strophanthus sargentosus</u>		Trastone, sactone
<u>Swertia chirata</u>	}	Antimalarial, antipyretic, anti-infectious; for diarrhoea, jaundice
<u>Swertia moorcroftiana</u>		
<u>Tamarindus indica</u>	Paip	Laxative
<u>Taraxacum officinalis</u>		Diuretic; for chronic disorders of kidney and liver
<u>Terminalia arjuna</u>		
<u>Terminalia belerica</u>		Laxative, antipyretic; for dropsy, haemorrhoids
<u>Terminalia belerica</u>	Fruit	Bitter tonic, astringent
<u>Terminalia chebula</u>		Antidysenteric
<u>Thapsia garganica</u>		Rubefiant
<u>Tinospora cordifolia</u>	Plant	Anthelmintic
<u>Tinospora cordifolia</u>	Stem	In diabetes
<u>Trachespernum amni</u>		Antispasmodic; in cholera
<u>Valeriana wallichii</u>		Carminative; in nervous disorders
<u>Vernonia amygdalina</u>		Vermifugal, antiviral
<u>Veronia anthelminticum</u>		Anthelmintic
<u>Veronia cinerea</u>		Antifilarial, antipyretic
<u>Vitex glabrata</u>	Leaves	In diabetes
<u>Zanthoxylum armatum</u>		In dyspepsia and cholera
<u>Zingiber officinalis</u>		Antidysenteric



Annex III

IMPORTANT PLANT DRUGS SUITABLE FOR  
PRODUCTION BY DEVELOPING COUNTRIES

Therapeutic Group	Essential		Second category	
	Plant	Active constituent	Plant	Active constituent
Anaesthetics	-	-	-	-
Analgesics, antipyretics,	<u>Papaver somniferum</u>	Morphine Codeine	<u>Aesculus</u> <u>Hippocastanum</u> <u>Aesculus indica</u>	Aescine and total extract
Nonsteroidal anti-inflammatory drugs and antigout drugs	<u>Gloriosa superba</u>	Colchicine	-	-
Antiallergics	-	-	<u>Combretum</u> <u>micranthum</u>	Extract
Antidotes, chelating agents, cholagogue	-	-	-	-
Anti-epileptics	-	-	-	-
Anti-infective	<u>Cephaelis ipecacuanha</u>	Emetine	-	-
Antiprotozoal	<u>Cinchona sp.</u>	Quinine	-	-
Anthelmintic	-	-	<u>Chenopodium</u> <u>ambrosioides</u> <u>Artemisia maritima</u>	Ascaridol, total extract Santonin
Antimiigraine	<u>Claviceps purpurea</u>	Ergotamine	-	-
Antineoplastic	<u>Catharanthus roseus</u> <u>Catharanthus lanceus</u>	Vinblastine Vincristine	<u>Podophyllum</u> <u>hexandrum (P. emodi)</u> <u>Prunus africana</u>	Podophyllotoxin and total extract Total extract (specific for prostate enlargement)

Antiparkinsonism  
 Blood and haemostoplastic  
 system  
 Cardiovascular  
 Antihypertensive

Anti-arrhythmic

Cardiotonic

Dermatological  
 preparations

Diagnostic agents  
 Diuretics  
 Gastrointestinal drugs  
 Antispasmodics

Muscle Relaxants

Bambusia serpens  
Bambusia vomitoria  
Bambusia confertiflora  
Catharanthus roseus  
Catharanthus lanceolatus

Vinca minor  
Vaccinium africanum a/  
Vaccinium thouraii a/  
Cinchona sp.  
Bambusia serpens and  
 other species  
Digitalis lanata

Azadirachta indica  
Centella asiatica

Theobroma cacao  
Duboisia myoporoides  
Duboisia leichhardtii

Atropa belladonna  
Atropa acuminata  
Datura sanguinea  
Datura stramonium  
Datura metel  
Hycosyamus maticus  
Hycosyamus niger  
Physoclaina prealta

L-Boys

Beseripine

Bambusia sp.  
Azadirachta indica

Vincamine

Quinidine  
Ajmaline

Digoxin and  
Lanatosides

Leanthoxin  
Asiaticoside

Theophylline

Total alkaloids  
atropine or  
hyoscyamine

Strophanthus gratus  
Thevetia neriifolia  
Urginea scilla  
(Scilla maritima)  
Psoralea corylifolia  
Psoralea

Strophanthin  
Peruvoside  
Proscillaridine  
Rutin or bioflavonoids

a/ Provides raw material for drug production.

Cathartics	<u>Cassia angustifolia</u> <u>Cassia italica</u> <u>Cassia acutifolia</u> <u>Plantago ovata</u> <u>Glycyrrhiza glabra</u>	Sennosides mixture of sennosides A,B as such and pro-ducts glycyrrhetic acid and extract <sup>a/</sup> Berberine	<u>Rhus</u> sp. <u>Alloe</u> sp.	Total extract Aloin
Laxatives				
Anti-ulcer				
Antidiarrhoeal	<u>Berberis aristata</u>	Diosgenin <sup>a/</sup>	<u>Ceratonia siliqua</u>	Total extract
Hormones	<u>Dioscorea deltoidea</u> <u>Dioscorea floribunda</u> <u>Dioscorea composita</u> <u>Costus speciosus</u> <u>Solanum laciniatum</u> <u>Solanum khasianum</u> <u>Solanum xanthocarpum</u> <u>Agave sisalana</u>	Solasodine <sup>a/</sup> Hecogenin <sup>a/</sup>		
Immunologicals				
Muscle Relaxants (peripherally acting) and antagonists	<u>Physostigma venenosum</u> <u>Chondrodendron tomentosum</u> <u>Pilocarpus</u> sp. <u>Physostigma venenosum</u> <u>Tuboisia myoporoides</u>	Physostigmine d-Tubocurarine Pilocarpine Physostigmine Atropine <sup>a/</sup> (as homotropine)		
Ophthalmological preparations				
Oxytocics	<u>Claviceps purpurea</u>	Ergometrine		Reserpine and crude extract
Psychotherapeutic			<u>Rauwolfia serpentina</u> <u>Rauwolfia confertiflora</u> <u>Rauwolfia vomitoria</u> <u>Valeriana wallichii</u> <u>Valeriana officinalis</u>	total extract total extract

<sup>a/</sup> Provides raw material for drug production.

Drugs acting on the respiratory tract	<u>Ephedra Gerardiana</u> ( <u>Ephedra vulgaris</u> )	Ephedrine	<u>Glycyrrhiza glabra</u> <u>Glycyrrhiza uralensis</u> <u>Licorice</u>	Total extract
	<u>Ephedra nebrodensis</u>		<u>Glycyrrhiza viciacea</u>	
	<u>Theobroma cacao</u>	Theophylline a/ (as aminophylline)	<u>Glaucus flavus</u>	Glaucosine
	<u>Papaver somniferum</u>	Codaine	<u>Polygala senega</u>	Total extract
Solutions correcting water, electrolyte, and acid-base disturbances	-	-	-	-
Vitamins and minerals	-	-	-	-

2/ Provides raw materials for drug production.

Annex IV

**OTHER PLANTS OF ECONOMIC IMPORTANCE AND EXPORT POTENTIAL**

Acacia senegal (A. Arabic)

Carica papaya Ananas

Chrysanthemum cinerariifolium

Cela nitida

Cymbopogon flavus

Derris elliptica

Eucalyptus sp.

Mentha sp.

Passiflora sp.

Ricinus communis

Soybean (for sitosterol)

Sterculia setigera

Sugar-cane press mud (for stigmasterol)

Annex V

**BIOLOGICALLY ACTIVE PLANTS FOR WHICH DRUG DEVELOPMENT  
HAS REACHED AN ADVANCED STAGE**

<u>Plant</u>	<u>Part of plant used</u>	<u>Properties</u>
<u>Amnona muricata</u>	Seeds	Oxytocic
<u>Alpinia siamensis</u>	Rhizome	Antibacterial, insect repellent
<u>Adhatoda vasica</u>	Leaves	Oxytocic
<u>Asclepias curassavica</u>	Seeds	Cardiotonic
<u>Brucea amarissima</u>	Fruit	Anti-amoebic
<u>Casimiroa edulis</u>	Seeds	Hypotensive
<u>Chenopodium foetida</u> C.Graveolens	Leaves	Antiparasitic
<u>Coleus forshoklii</u>	Roots	Hypotensive
<u>Commiphora mukul</u>	Resin	Hypolipidaemic
<u>Derris trifolia</u>	Root	Antispasmodic
<u>Echinops spinosus</u>	-	Vasoconstrictor
<u>Ipomoea pescaprae</u>	Plant	Antihistaminic, anabolic
<u>Perettia hebeciada</u>	Roots	Laxative
<u>Ruta chalepensis</u>	Leaves, stem	Oxytocic
<u>Strobilus asper</u>	Seed	Antibacterial, antiseptic
<u>Sapindus mukorosi</u>	Seeds	Spermicidal
<u>Zingiber cassumunar</u>	Rhizome	Muscle relaxant, analgesic

ANNEX VI

**THE IMPORTANT EXCIPIENTS**

<b>Sterile products</b>	<b>Distilled water (sterile and pyrogen free)</b>
<b>Syrups</b>	<b>Sugar syrup Syrup Tolu Syrup Auranti</b>
<b>Ointment</b>	<b>Lanolin Petrol jelly Cetosteryl alcohol Macrogog</b>
<b>Suppositories</b>	<b>Gelatin, cacao butter</b>
<b>Tablets</b>	<b>Starch, lactose Microcrystalline cellulose Polyvinyl pyrrolidone Shellac Wax Silicones</b>
<b>Capsules</b>	<b>Gelatine</b>
<b>Tinctures and galenicals</b>	<b>Alcohol</b>

Annex VII

FACILITIES AVAILABLE IN VARIOUS COUNTRIES

AFRICA

ALGERIA

- |   |   |                                  |
|---|---|----------------------------------|
| 1 | Laboratoire de matière médicale et pharmacologie<br>Faculté de pharmacie<br>ALGIERS                                     | Phytochemistry<br>Pharmacology   |
| 2 | Laboratoire de recherche, développement et<br>contrôle pharmacie centrale algérienne<br>Lavignerie - EL HARRACH ALGIERS | Galenique<br>Analysis<br>Control |

EGYPT

- |   |   |                |
|---|---|----------------|
| 1 | Natural Research Center<br>Laboratory of natural products<br>Dokki, CAIRO | Phytochemistry |
| 2 | Department of Pharmacognosy<br>Faculty of Pharmacy, CAIRO                 | Phytochemistry |

IVORY COAST

- |   |  |  |
|---|--|--|
| 1 | Institut ORSTOM<br>ADIPODOUNE  | Botany<br>Phytochemistry<br>Pharmacology |
| 2 | Laboratoire de botanique<br>Laboratoire de chimie<br>Faculté des sciences<br>ABIDJAN | Botany<br>Phytochemistry                 |

MADAGASCAR

- |   |   |  |
|---|---|--|
| 1 | Centre national de recherches pharmaceutiques<br>TANANARIVE | Botany<br>Phytochemistry<br>Pharmacology |
|---|---|--|

NIGERIA

- |   |   |                |
|---|---|----------------|
| 1 | Institute of traditional medicine<br>Faculty of Pharmacy<br>University of Ife | Phytochemistry |
|---|---|----------------|



**SUDAN**

- 1 National Industrial and Consulting Institute  
KHARTOUM

**RWANDA**

- 1 Groupe de recherches pour la médecine traditionnelle, la pharmacopée et les plantes médicinales rwandaises  
Université nationale du Rwanda  
BUTARE

Botany  
Phytochemistry  
Pharmacology

**ASIA**

**INDIA**

- 1 Central Drug Research Institute  
LUCKNOW
- 2 Central Indian Medicinal Plants Organisation,  
LUCKNOW
- 3 National Botanic Gardens,  
LUCKNOW
- 4 Regional Research Laboratory,  
Srinagar, KASHMIR

Botany  
Chemistry  
Pharmacology  
Instrumentation  
Pharmaceuticals  
Process development  
Fermentation technology

Cultivation  
Propagation  
Collection  
Production

Plant breeding  
Tissue-culture methods  
for propagation of  
plants herbarium

Botany  
Chemistry  
Pharmacology

**PAKISTAN**

- 1 H.E.J. Postgraduate Institute of Chemistry,  
University of Karachi,  
KARACHI-32

Centre for instrumentation (infrared, ultraviolet, nuclear magnetic resonance and mass spectrometry)  
Micro-analysis  
General pharmacological screening

**NEPAL**

- 1 Department of Medicinal Plants  
Thapathali, KATHMANDU
  - (a) Royal Drug Research Laboratory  
Phytochemical and pharmaceutical investigations
  - (b) Botanical Survey and Herbarium  
Plant identification
  - (c) Royal Botanical Garden  
Germplasm centre for medicinal plants and seeds
  - (d) Herbal farms  
Cultivation of medicinal herbs and essential oil-bearing plants

**THAILAND**

- 1 Applied Scientific Research Corporation of Thailand (ASRCT) (Pharmaceutical Research Division)  
196 Paholyothin Road, Bangkok,  
BANGKOK  
Research work applied to drug industry
- 2 Department of medical sciences  
Ministry of Public Health, Yoesae,  
BANGKOK  
Basic research and routine investigation

**LATIN AMERICA**

**CUBA**

- 1 Estacion Experimental de plantas medicinales, "Dr. J. T. Roig"  
Apdo, 33 Guira de Melena,  
HAVANA  
For cultivation of plants

**MEXICO**

- 1 Instituto Mexicano Para El Estudio de Plantas Medicinales (INEMPLAN)  
MEXICO 12 D.F.  
For ethnobotanical service and chemical and pharmacological investigation of plants

**ANNEX VIII**

**LIST OF DOCUMENTS**

- |                    |  |
|--------------------|--|
| <b>ID/WG.271/1</b> | <b>Plants of the African pharmacopoeias<br/>used in the treatment of tropical diseases<br/>J. Kerharo</b>        |
| <b>ID/WG.271/2</b> | <b>Industrial requirements for processing<br/>medicinal plants<br/>E. Bombardelli</b>                            |
| <b>ID/WG.271/3</b> | <b>An integrated approach to research on<br/>medicinal plants<br/>N. Anand</b>                                   |
| <b>ID/WG.271/4</b> | <b>Medicinal plants for curing diseases other<br/>than communicable, tropical and infectious<br/>P. Sandberg</b> |
| <b>ID/WG.271/5</b> | <b>List of participants</b>  |

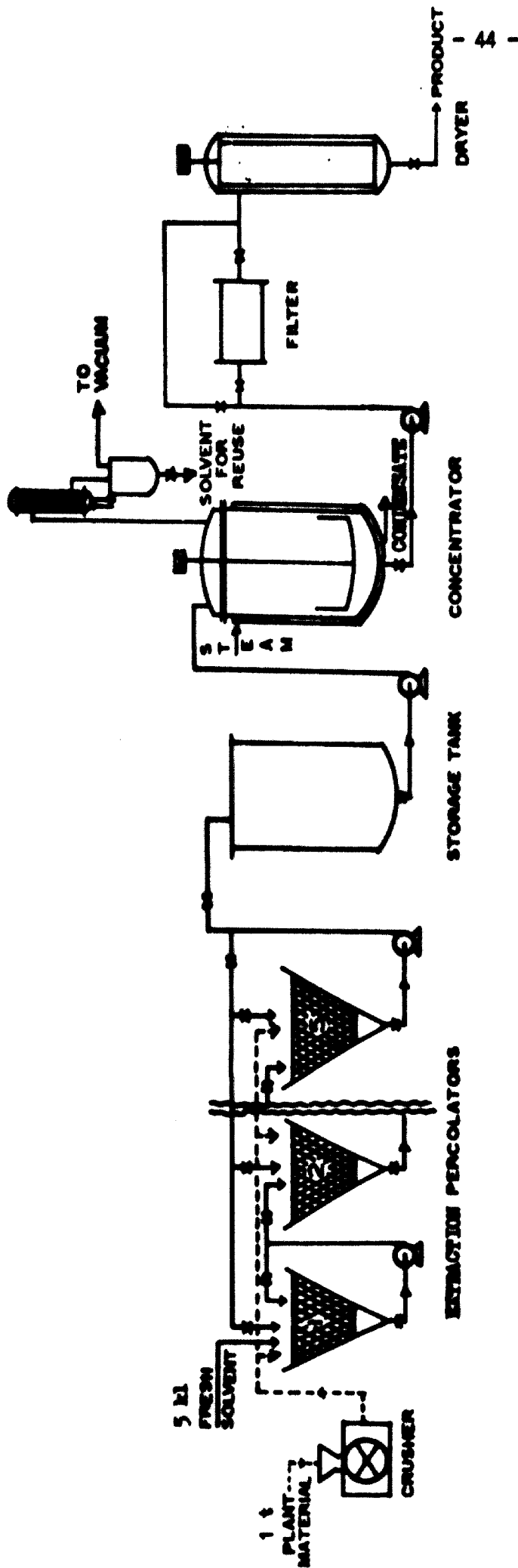
APPENDIX IX

A MODEL UNIT FOR THE PREPARATION OF CRUDE EXTRACTS

The sequence of unit operations involved in processing 1 ton (t) of material per day is indicated in the flow chart below. Depending on the nature of the desired final product, the concentrate obtained can be processed further.

Only the major process equipment is shown in the flow chart. The complete list of equipment for the unit is as follows:

<u>Item</u>	<u>Capacity</u>	<u>Number required</u>
<u>Process equipment</u>		
Weighing balance		1
Hammer mill with sieving arrangement	100 kg/h	1
Percolator, stainless steel	1 500 l	5
Circulation pump, stainless steel, head 10 m	500 l/h	8
Storage tank, stainless steel	3 000 l	1
Concentrator, stainless steel, jacketed with agitator	500 l	2
Shell-and-tube heat exchanger, stainless steel, surface area 2 m <sup>2</sup>	250 l	2
Receiver, stainless steel		1
Solvent recovery plant		1
Filter		1
Dryer		1
<u>Service equipment</u>		
Boiler, pressure 10 bar	300 kg/h	1
Vacuum pump, water-ring type, vacuum up to 0.06 bar	80 m <sup>3</sup> /h	2
Chilled-water circulation unit	20 t	1
<u>Analytical instruments</u>		
pH meter		1
Thin-layer chromatography equipment with ultraviolet lamp		1
Spectrophotometer, ultraviolet		1
Centrifuge, laboratory model		1
Soxhlet apparatus with bath		1
Vacuum pump, oil		1
Vacuum oven and muffle furnace		1
Microscope		1



Flow chart for a multipurpose phytochemical processing plant  
 (capacity 1 t/d)

## Annex I

### NATIONAL INFORMATION CENTRE FOR DRUGS AND PHARMACEUTICALS (NICMAP)

NICMAP is one of the four sectoral centres set up under the National Information System for Science and Technology (NISSTAT) by the Department of Science and Technology, Government of India. This Centre is located at the Central Drug Research Institute, Lucknow.

#### Mission

NICMAP serves as a central information agency for collection, storage, retrieval and dissemination of information relating to drugs and pharmaceuticals.

#### Users

Scientists and technologists in R and D organizations and industry  
Medical and veterinary colleges, schools of pharmacy, and university departments concerned with drug research  
Management executives in the Central and State Governments responsible for health-care programmes

#### General information

NICMAP has its base at the CDMRI Library, which subscribes to 350 national and foreign periodicals covering all scientific disciplines related to drug

research. Some important foreign periodicals are airlifted. Secondary periodicals, including Current Contents, Chemical Abstracts, Biological Abstracts, Science Citation Index, Scirp, Inpharm, and Tropical Diseases Bulletin are also subscribed to. Back issues of periodicals are available in many cases from the very first issue. The total collection of the library numbers around 30,000 volumes, which include books, annuals, serials, advances, patents specifications, technical reports and bound volumes of periodicals. The CDMRI Library uses the open-access system with self-explanatory catalogues.

#### Activities

NICMAP activities consist of nine major projects:  
Current Awareness Service  
R and D  
Industry  
Subject Bibliographies  
Patents Awareness Service  
New Drugs Bulletin  
Registry of Adverse Effects of Drugs  
Directory of Information Sources for Drugs  
Survey of Indian Drugs and Pharmaceuticals Industry  
Futuristic Studies  
Survey of Information Needs and Evaluation of Information Use

#### Services and Products

NICMAP issues three monthly bulletins:

Drugs and Pharmaceuticals:

Current Highlights (R and D)

Drugs and Pharmaceuticals:

Current Highlights (Industry)

Drugs and Pharmaceuticals:

Patents Awareness Bulletin

The Selective Dissemination of Information (SDI) service is also available.

Reproduction services include photocopying of documents available in the Centre (single copies for research purposes only).

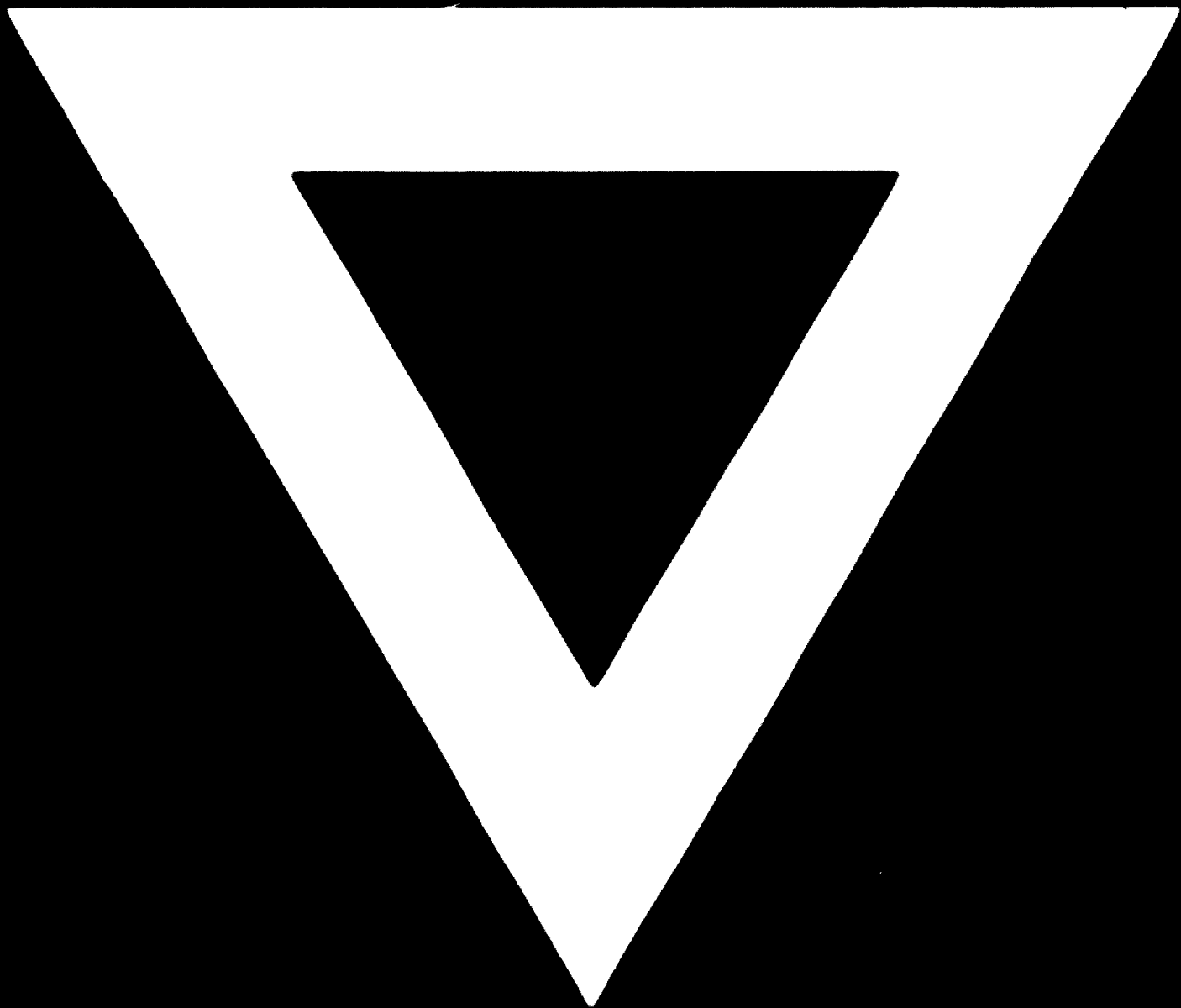
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