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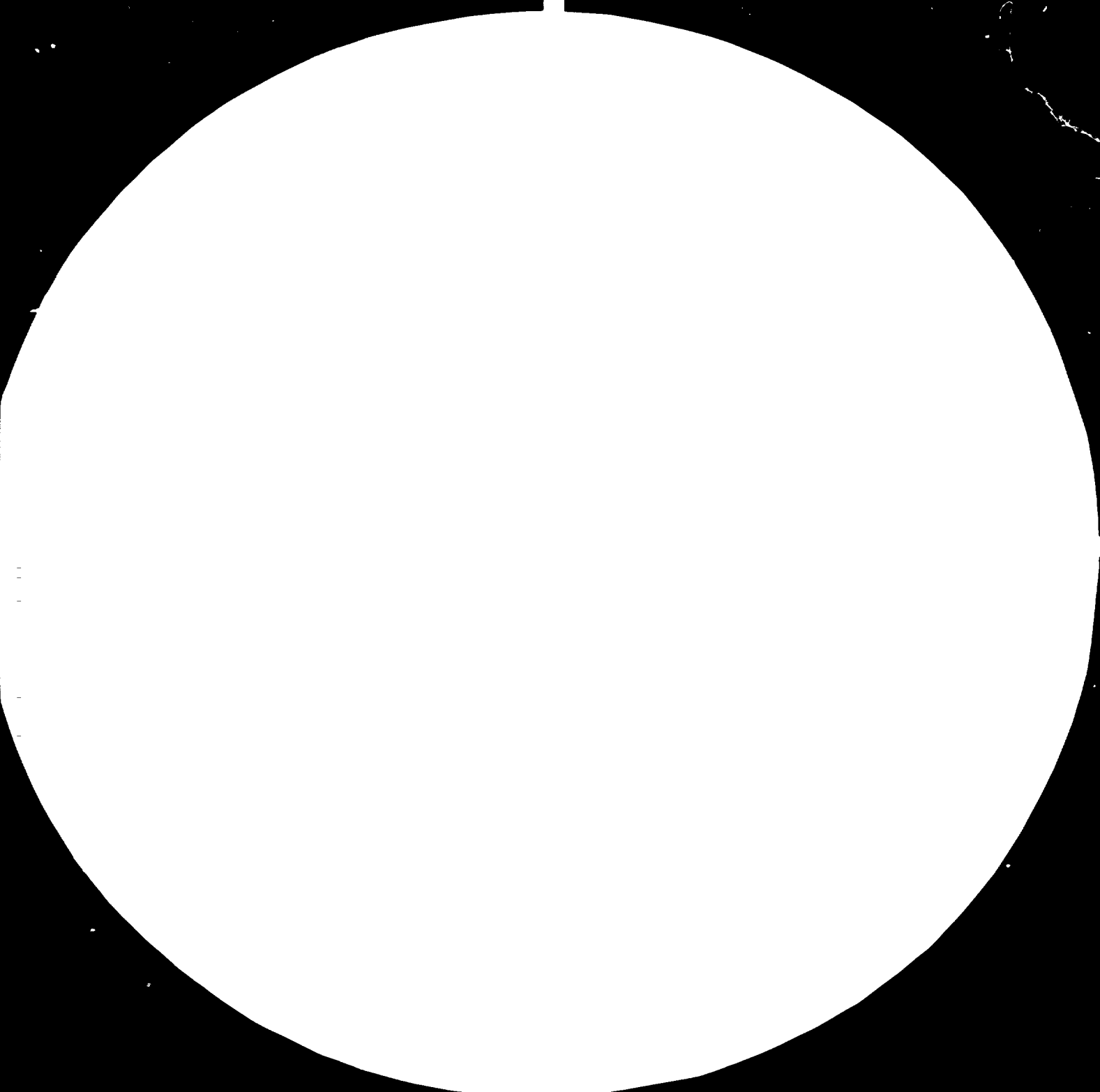

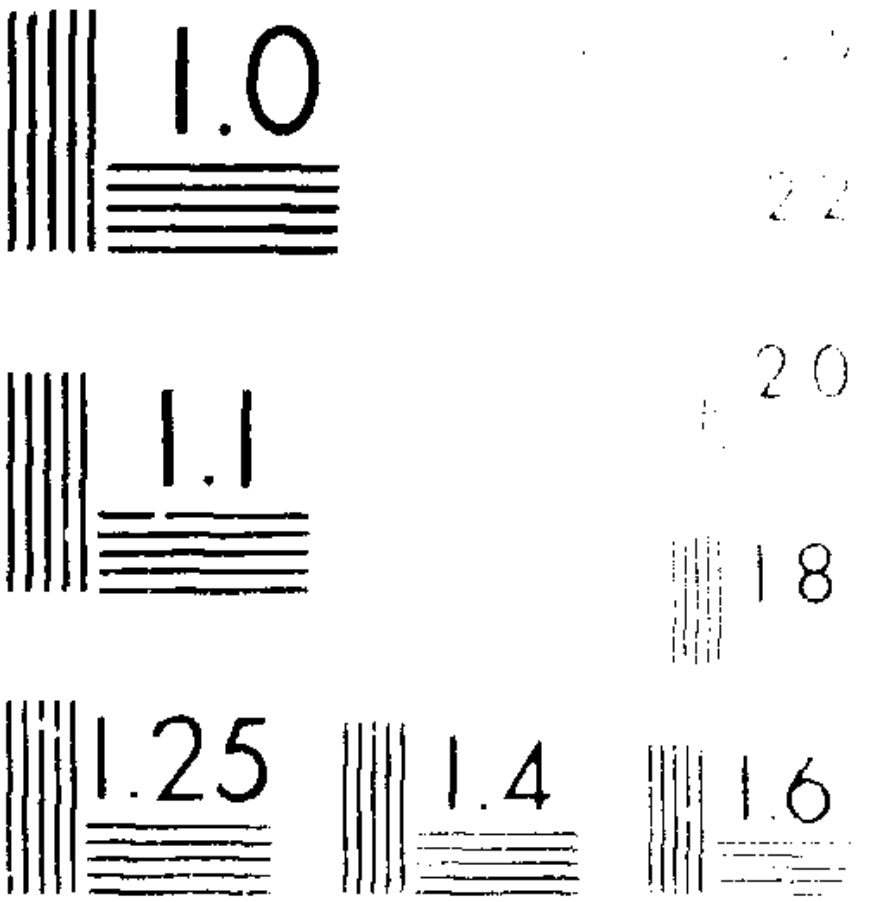
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MOBILE UNIT OF PHARMACEUTIAL AND ESSENTIAL OILS INDUSTRY TO THE LEAST DEVELOPED COUNTRIES IN AFRICA
3 NOVEMBER - 3 DECEMBER 1979

S U D A N

RP/RAF/79/005

Terminal Report*

Prepared for the Government of Sudan

Based on the work of

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United Nations Industrial Development Organization
Vienna

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S U M M A R Y

Within the framework of the UNIDO assistance programme for the industrial valorization of the medicinal plants and their use in medicine in the least developed countries, UNIDO charged the Joint UNIDO/ROMANIA Centre with the task to send a mobile unit to collect data about the available medicinal and aromatic plants and to examine the prospects to process them locally at a small scale industry. The obtained active principles will be used in the preparation of pharmaceuticals.

Six Romanian experts equipped with laboratory equipment, materials and two cars undertook a four weeks mission in Sudan from 3rd November to 3rd December 1979.

This was the second phase of the project entitled: "Mobile Unit for Pharmaceutical and Essential Oils Industry in the Least Developed Countries in Africa" - Exploratory mission - Phase 1 - Project nr.RP/RAF/77.

Taking into account the rich flora existing in certain regions of the Sudan, the present report presents the findings of the mission and the recommendations for further assistance consisting in training programmes for the local personnel, international experts, setting up a pilot unit and supply of laboratory equipment.

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2. Introduction

The United Nations Industrial Development Organization has a very important assistance programme for the development of a pharmaceutical industry based on the medicinal plants available in certain developing countries. Several programmes have been designed for different developing countries and some of them are already under implementation.

The utilization of medicinal plants has been always known in the developing countries and the largest part of the population made use of extracts or dry herbs for curing many tropical and epidemic diseases. Taking into account the increased demand for medicines in the world and in the developing countries too, a particular attention started to be focused on the possibility of medicines production on a more economic basis such as the utilization of medicinal plants which many developing countries are rich in.

In this respect a mobile unit visited Sudan between 3rd November 1979 and 3rd December 1979.

The present report refers to the activity of the mobil unit for the valorization of the medicinal plants in Sudan. Appendix 1 indicates the persons met by the UNIDO experts.

3. Flora

Sudan has important natural resources of medicinal and aromatic plants which can assure the necessary raw materials for the development of a small scale pharmaceutical and cosmetic industry.

The information and data about the medicinal flora were got during the travel within the country and from the local specialists of the "Medicinal and Aromatic Herbs Research Unit", Faculty of Pharmacy - Khartoum and the Industrial Research and Consultancy Institute - Khartoum.

The mobile unit collected samples and data of medicina and aromatic plants along the following route : Port Sudan, Wad Medani, Khartoum and its surroundings, El Obeid, Wan, Tombora, Yambio, apprex. 2600 Kms.

There is no organization dealing with the harvest and the processing of medicinal plants, except the local healers which collect plants and prepare remedies according to the traditional medicine in Sudan.

In the North of Khartoum there is an experimental farm for medicinal and aromatic plants belonging to the above mention Research Unit. At present, this unit has 4 ha available for experiments with the possibility to extend the farm to 90 ha. and irrigation facilities are also available. Except this farm there are no other organized cultures of medicinal plants.

Among the multitude of the medicinal and aromatic species growing in the spontaneous flora, the main 18 species available in outstanding quantities are listed in Appendix 2. The majority of these species are already tested and recognized by pharmacopoeia therefore they can be introduced under the form of pharmaceutical preparations in therapeutics to meet firstly the local requirements.

Among the species listed in Appendix 2, Vinca rosea (catharantus roseus), cultivated as ornemental plant, requires a particular attention as it is an important raw material for the preparation of medicines required in the treatment of some forms of leukaemia.

Another group of valuable medicinal and aromatic plants available in large quantities, are listed in Appendix 3.

These plants are insufficiently or not at all tested, but there are reliable indications that some of them are valuable from the pharmaceutical point of view. Balanites aegyptiaca, for instance, available in large quantities can be an important source of flavones and it is the subject of an UNIDO project.

In order to carry out the scientific screening of these species and of other species used by the local folk medicine it is highly required to train the local skilled personnel (botanists and phytochemists). The botanist of the Mobile Unit carried out demonstrations of economic mapping in front of local specialists and quantitative and qualitative evaluation of medicinal and aromatic plants growing in the spontaneous flora of a determined area was performed.

Due to the fact that Sudan disposes of large areas with favourable pedoclimatic conditions and the necessary labour available, it is advisable to introduce in culture species with therapeutical value listed in Appendix 4. To a large extent these species are well studied and recognised by pharmacopoeia and the culture technologies are also known.

The UNIDO experts handed over to the "Research Unit - Khartoum" seeds of 20 species of medicinal plantes brought from Romania to be introduced in culture. These species are presented in Appendix 5. These species should be firstly tested in the experimental farm of the "Research Unit" and later on they should be extended in cultures in favourable areas: the South and South-East regions and the Nile valley where irrigation facilities necessary for some species are at hand. Appendix 5 also presents the main elements of cultivation technology for these species.

4. Laboratory activity

The laboratory activity of the mobile unit took place in the laboratory of the "Medicinal and Aromatic Herbs Research Unit" belonging to the National Council for Research. The Unit comprises :

- Department of phytochemistry
- Department of pharmacology
- Department of microbiology
- Research farm

At present, the technical staff of the Unit consists in two researchers (chemist and pharmacologist), five assistant researchers (four pharmacists and one agronomist) and one qualifie technician. Four specialists follow training programme in various developed countries.

The Unit has already started to collect samples of plant to be botanically identified and phytochemically screened. Detaile investigations are in progress. An herbarium were also established within the unit.

The laboratory disposes of sufficient rooms as well as laboratory equipment, glassware and solvents but for the future development of activity some items should be procured.

The UNIDO experts carried out qualitative and quantitati determinations on the samples of medicinal plants collected during their mission in Sudan.

The content of alkaloids in the leaves of Datura stramonium was 0.17% expressed in Hyosciamine compared with the minimum content of 0.25 % indicated in the technical literature This low content of alkaloids can be explained by the collection of the leaves in an unfavourable season. The tincture of stramonii was prepared from the Datura stramonium leaves and qualitative and quantitative analyses were carried out.

The tinctures of Eucalypti and Capsici were also prepared The content of essential oils in the aromatic plants collected by the mobile unit was also determined. The results of the chemical analyses are indicated in Appendix 6. Based on these good results in active principles we consider useful to establis pilot units for extraction and distillation.

The lower content of essential oils in the samples of Folium eucolypti, Fructus foenionli and Fructus coriandri could be explained by the unfavourable period in which the collection was done.

The study on the dynamical accumulation of essential oils in plants can lead to the determination of the best period of harvesting.

Besides the above mentioned chemical determinations, the UNIDO experts demonstrated to the local specialists an identification methodology of active principles in plants with an unknown chemical composition (See Appendix 7). For this demonstration the flowers and the fruits of Hibiscus subdoriffa were used and saccharides, antocyanosides and polyuronides were obtained.

The Sudanese specialists have been very interested in this methodology and they wished to apply it in the research of the medicinal plants used in the traditional medicine where the chemical composition is unknown.

For the further development of the laboratory activity, some more laboratory equipment and glassware should be procured. A proposal of such items to be procured is indicated in Appendix 9.

5. Pharmaceutical industry

Only some small subsidiaries of European companies for the conditioning of some medicines based on imported raw materials operate in Sudan.

There is not a pharmaceutical industry using the local raw materials including medicinal plants but a relatively large network assures the distribution of the standardized medicines to the population.

Checking the list of imported medicines it was noted that some preparations can be locally produced using unsophisticated technologies like for Tictura Daturae, Syrup of Sennè, etc.

Some aromatic cosmetics are also particularly demanded by the people and the Sudanese specialists are very interested in setting up a distillation unit to get essential oils for the preparation of such aromatic cosmetics.

Based on the medicinal plants growing in the spontaneous flora and by studying the morbidity statistics, the UNIDO experts carried out in co-operation with the local specialists demonstrations on the preparation of some pharmaceutical products which could be immediately introduced in therapeutics of some current affections of digestive and breathing system, rheumatism, a.s.o.

The list of the pharmaceutical products prepared by the UNIDO experts is indicated in Appendix 8.

At the same time the experts explained to the Sudanese researchers the methodology to obtain some total extracts of plants which could be used in the preparation of pharmaceutical formulae. At the first stage, it is advisable to use total extracts of plants which do not rise particular technical problems but the dosage of these extracts should be precisily carried out and demonstrations had been done in this respect.

The use of medicinal plants recognized by pharmacopaie does not imply difficult tests of pharmacodynamical activity and toxicological effects.

The medicines that were obtained at a laboratory scale by the UNIDO experts could be prepared at a pilot scale. Other similar medicines could be prepared on the same scale.

Among the valuable species of medicinal and aromatic plants available in important quantities in the spontaneous flora, some species merit a particular attention. They can be used as raw materials at an industrial scale, for instance Datura stramonium, Vinca rosea, Ricinus comunis, Acacia senegal and others.

6. Findings

a) The spontaneous flora of Sudan, ospecially in the center and the South of the country, is very rich in various species of medicinal and aromatic plants which can be a valuable raw material for the setting up of a pharmaceutical industry.

b) The "Medicinal and Aromatic Herbs Research Unit - Khartoum" started the screening of medicinal plants.
In order to establish a pharmaceutical industry based on these plants it is necessary to establish a complete inventory of the plants and the quantity of plants which can be annually harvested in each region without disturbing the natural balance of the ecological system.
There is not a specialized organization to collect and process the medicinal and aromatic plants.

c) Sudan has large possibilities to introduce or to organize the cultures of medicinal and aromatic plants taking into account the favourable pedoclimatic conditions, large areas suitable for such cultures and the availability of the necessary labour.
The organization and the development of medicinal plant cultures will assure the internal requirements and will provide large export disponibilities with a direct impact on the reduction of imported pharmaceuticals and will make a better use of the natural resources and labour employment.

d) The Sudanese specialists should urgently undertake a specialized training in this field of botanical/screening (botanists), organization of cultures (agronomists), chemical determinations and tests (analysts) and processing of medicinal plants and preparation of pharmaceutical products (pharmacists).

This is the first requirement for a further development of the valorization of the medicinal plants and the establishment of a small scale pharmaceutical industry.

e) The existing facilities of the"Medicinal and Aromatic Herbs Research Unit" laboratory can assure the research and laboratory control of the raw materials and of the pharmaceutical preparations if suitable laboratory equipment is fitted in and the skilled personnel is provided.

f) There is no extraction and distillation pilot units to assure the development of technologies and the process of medicinal and aromatic plants.

7. Recommendations

Taking into account the rich spontaneous flora of Sudan and the favourable pedoclimatic conditions for the organizatio of medicinal and aromatic plants cultures, the following recommendations are submitted for consideration in order to set up a small scale pharmaceutical industry.

7.1. "The Medicinal and Aromatic Herbs Research Unit" should organize a quantitative and qualitative evaluation of the medicinal and aromatic plants growing in the spontaneous flora and should assess the quantities that can be annually harvested. An economic mapping should be carried out by the local botanists with the assistance of international experi especially in the central part and the Southern region of Sudan.

7.2. The setting up of a specialized economic organization to control the harvest of the herbs from the spontaneous flora and the development of the medicinal and aromatic plant cultures. Such organization should also take care and protect the natural balance of the ecological system during the exploitation of the spontaneous flora.

The following guidelines have to be observed during the annual harvest of :

- underground organs of plant (roots, rhisomes, bulbs, a.s.o. only 30% from the existing quantity;
- aerial parts of the perennial species - only 30-40% from the existing quantity;
- leaves, flowers, fruits and seeds - only 40-60% from the existing quantity.

In order to collect a raw material of high quality it would be advisable to issue some prospects in the local language, with drawings indicating the right parts of the plant to be harvested and the suitable drying and packaging methods.

7.3. The experimental farm of the "Medicinal and Aromatic Herbs Research Unit" has to organize the experiments with the medicinal and aromatic herbs under better conditions. Other experimental stations would be advisable to be set up in the South-East region and in the Nile Valley in order to extend the culture of valuable medicinal species.
The experimental farm has to be endowed with agricultural inventory (tractor, plaugh, disc, harrow, irrigation pumps, balance, etc.) as well as an adequate space for herbs drying.

7.4. The Sudanese skilled personnel should be trained to cultivate and process the medicinal and aromatic plants and to formulat pharmaceutical preparations from them.
It is strongly recommended that 4 fellowships holders (one botanist, one agronomist, one phytochemist and one technologist) should undertake a training programme. Such training programme should be organized by UNIDO during 1980. The training of the local personnel is a first action to be implemented and it is a condition for the further development of this project.

7.5. A local assistance to be granted by 3 international experts in order to develop and accelerate the research and production activities of pharmaceuticals based on medicinal plants :
- one agronomist for 6 months - best period: August-January;
- one analyst for 3 months - after the delivery of laboratory equipment - see item 7.6.-
- one technologist - for 6 months - after the delivery of pilot plant equipment jointly with an analyst - see item 7.6. The technologist will assure the installation of the pilot unit equipment.

7.6. In order to set up a small scale pharmaceutical industry based on medicinal and aromatic plants, the existing laboratory of the unit should be completed with the apparatus and materials listed in Appendix 9.

The same Appendix 9 indicates the necessary equipment for an extraction and distillation pilot unit.

During the experts' mission a draft project proposal concerning the further assistance to Sudan, as above mentioned, was discussed with the management of the "Medicinal and Aromatic Herbs Research Unit".
The total amount of the future assistance is evaluated at U.S. $.127,500.-

APPENDIX 1

L I S T

of persons met by the UNIDO mission

1.- Mr. Peter Quennell
Assistant to the Resident Representative.

2.- Mr. S.J.Szivos - SIDFA

3.- Mr. dr. Yahia M. Elkhier
Dean, Faculty of Pharmacy

4.- Mr. dr. Ibrahim Abu-Al-Futuh
Head, Section of pharmaceutical industries,
Department of the Industrial Research & Consultancy
Institute.

5.- Miss Salama Hamid
Industrial Research & Consultancy Institute

6.- Mr. Makram Eido George
Ministry of Industry.

7.- Mr. dr. Saad Mohamed Hussein Ayoub
Director, Medicinal and Aromatic Herbs Research Unit -
N.C.R.

8.- Mr. Elhadi Nur Eldayem
Medicinal and Aromatic Herbs Research Unit.

9.- Mr. Abdel Khaliq Muddathir
Medicinal and Aromatic Herbs Research Unit.

APPENDIX 2

Medicinal and aromatic plants growing in outstanding quantities in the spontaneous flora and recognized by pharmacopoeia

No.	Botanical name	Spreading (see note)	Part used	Composition	Therapeutica effects
1.	Cassia acutifolia	Spontaneously cultivated in the North and Central regions.	Folium Sennae	Antracenosides (emodina, reina), flavones	purgative laxative
2.	Ricinus communis	Everywhere spontaneously and cultivated.	Semen	Oil 4o-5o% ricin	purgative
3.	Capsicum fructesoens	Cultivated in central and western regions.	Fructus capsici	Alkaloids acids	
4.	Datura stramonium	Spontaneously	Folium herba	Total alkaloids o.23 - o.37%	antiparkinso. effects depressive
5.	Datura innoxia	Spontaneously	Folium herba	Total alkaloids o.23 - 0.39% (scopolamine)	- " -
6.	Rauwolfia vomitoria	Spontaneously in Southern region.	Rhisome Radix	indolic alkaloids (0.8-1.3%)	sedative nervous cardiac
7.	Vinca rosea (Catarathus roseus)	Spontaneously and cultivated in central region.	Herba	Alkaloids (vincaleuco-blastine)	antileukaemi.
8.	Carica papaia	Everywhere spontaneously and cultivated	Juice of fruits	papaine	gastro-enteritis dyspepsia
9.	Cucurbita pepo Cucurbita maxima	Everywhere	Semen	Fat oils (50%)	antihelminti.

APPENDIX 2

No.	Botanical name	Spreading (see note)	Part used	Composition	Therapeutical effects
10.	Foeniculum vulgare	Cultivated in Northern region.	Fructus	Essential (4-6%) oil	Carminativ
11.	Anethum graveoleus	Cultivated in Central region.	Fructus	Essential oil (4%)	
12.	Citrullus colocynthis	Spontaneously in Northern region.	Fructus	Fat oil (23%)	purgative

Note: The indication "cultivated" means that the species are cultivated for other purposes (as food) than medicinal plants.

APPENDIX 3

Medicinal and aromatic plants available in large quantities but which should be pharmacologycal studied and tested.-

No.	Botanical name	Spreading
1.	Hibiscus subderiffe	Cultivated in central and southern regions.
2.	Tamarindus indica	Spontaneous in the central region.
3.	Accacia nilotica	Spontaneous in the northern and central regions.
4.	Solenostema argel	Spontaneous and cultivated in northern region.
5.	Mentha viridis	Cultivated in Nile Valley.
6.	Cymbopogon proximus	Spontaneous in the northern and central regions.
7.	Lupinus ternais	Cultivated in the northern and central regions.
8.	Balanites aegyptiaca	Spontaneous in the Central region and the Nile Valley.
9,	Cuminum ciminum	Cultivated in the northern region.
10.	Lawsonia alba	Cultivated and spontaneous in the northern and central regions.
11.	Salvadova persica	Spontaneous in the central and southern regions.

APPENDIX 4

Medicinal and aromatic plants recommended to be introduced in culture

No.	Botanical name	Part used	Period of harvest	Composition	Therapeutic effect
1.	Pimpinella anisum	Fructus	yellowed flowers	essential oil	carmin tive.
2.	Mentha piperita	Herba	complete blooming	- " -	anti-spasmo dic.
3.	Mentha crispa	Herba	- " -	- " -	cosmet
4.	Matricaria Chamomilla	Flores	when the flowers are in horizontal position.	- " -	cicatr zant.
5.	Carum carvi	Fructus	when the fruits become brown	- " -	carmi-nativ
6.	Cinchona sp.	Cortex	-	alkaloids	anti-malar cardi depre sant.
7.	Strychnos nuxvomica	Cortex	-	alkaloids	toxic paral sis.
8.	Strophantus sp.	Semen	before opening the fruits	heterosides	cardi tonic
9.	Saponaria officinalis	Radix	when the vegetation is finished	saponines	expec rant
10.	Coriandrum sativum	Fructus	when the fruits become yellow	essential oil	carmi tiv
11.	Tussilago farfara	Folia	After blooming	mucilage	emoll ent
12.	Rosa cannina	Fructus	when the fruits become red.	ascorbic acid, glucides	vitam zing

APPENDIX 5

L i s t

of medicinal and aromatic plant species recommended to be introduced in culture.
The seeds of these species were brought by the UNIDO exports from Romania.
The main elements of cultivation technology.

No.	Botanical name	Previous culture	Fertilisers				Soil works		Sowing				Maintenance works	Harvest			Production	
			Manure	P_2O_5 kg/ha a.s.	K_2O kg/ha a.s.	N kg/ha a.s.	Ploughing depth cm	Before sowing	Month	Quantity kg/ha	Distance cm	Depth cm		Period	Manner of harvesting	Drying	Part used	Efficiency kg/ha
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1.	Atropa bella-donna	-vegeta-bles -cereal -not after sola-naceae	20-30	70-80	45-55	90	28-30	-disk -harrow -roller	X XI	4-6	60 x 15	1.5-2	-hood -weeded -thined	-leaves -roots in 2nd year.	manual 1-2 harvests	at shadow t° max. 50-60°C	dryed leaves (6-7:1) dryed roots (4-5:1)	500-600 700-1000
2.	Colen-dula offici-nalis	-plants with annual hoeing	-	60-80	-	40-50	20-25	-disk -harrow	III	6-7	30	2-3	-hood -weeded	-flowers	manual	at shadow t° max. 40-50°C	dryed flowers (8:1)	1000-2000
3.	Carum carvi	-plants with annual hoeing -cereal	-	40-50	60-70	45-50	28-30	-disk -harrow -roller	III	10-12	50	1.5-3	- " -	when 35-40% of fruits are yellow	-"-	drying and selection	fruits	700-1000

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
4.	Coriandrum sativum	-plants with annual hoeing -cereal	-	40-50	30-35	60-70	20-25	-disk -harrow	III	15-18	50-or 25	4-5	-hoed -weeded	when 50-70% of fruits are yellow	mechanical means	drying and selection	fruits	10 15
5.	Cynara scolymus	-plants with annual hoeing	-	60-70	50-65	70-80	28-30	-disk -harrow	V	4-5	70	3-5	-"-	green leaves	manual	at shadow t° max. 50-60°C.	dryed leaves (6-7; 1)	150 300
6.	Datura innoxia	-plants with annual hoeing with manure; -not after solanaceae	-	60	60	120	28-30	-"-	IV	10-12	50	4-5	-"-	herbs when appears first fruit	manual	at shadow t° max. 60-70°C	dryed herbs (6-9: 1)	250 300
7.	Digitalis lanata	-plants with annual hoeing	-	40-80	-	45-50	20-25	-disk -harrow -roller before and after sowing	III	3-4	50	1-1.5	-"-	when the leaves have 3 months	manual	at shadow t° max. 35-40°C	dryed leaves (5-6; 1)	100 200
8.	Foeniculum officinale	-cereal -not to be sowed in fields with Cusaita sp.	-	40-50 annual	-	60-70 annual	28-30	-disk -harrow	III	8-10	60	2-3	-"-	when the fruits are yellow-brown	manual or with mechanical means	drying selection.	fruits	600 1000

APPENDIX 5

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
).	Lavandula angustifolia	It will be planted besides crop-rotation	40-50 at the beginning.	45-70	150-200 each year	85-100	45-60	level-ling -disk -harrow	shoot XI-XII plantation X-XI	-	100 x 50	-	-hoed -weeded	when 50% of flowers are open	manual flowers with 10-12 cm stem	by distillation	green inflorescence	5000 6000
).	Matricaria chamomilla	plants with very short vegetation period	-	40-50	45-50	40-50	15-20	level-ling -disk -harrow -roller	VIII-IX	4-5	25	0.3-0.5	-weeded	when majority of flowers are horizontal	manual	at shadow t° max. 30-35°C	dryed inflorescence (5:1)	600-800
).	Ocimum basilicum	plants with annual hoeing/very clean	-	40-50	30-40	50-70	20-25	-disk -harrow -roller	IV	4-6	50	1.5-2	-hoed -weeded	at complete to blooming of main inflorescence	with sickle	at shadow t°. max 30-35°C	dryed herba (5:1)	1500-2000
).	Pimpinella anisum	-plants with annual hoeing -very clean	-	50-60	-	70-80	20-25	-disk -harrow	III	10-12	50	2-3	-hoed -weeded	when 50% of fruits are yellow-grey	with sickle	-drying -selection	fruits	500-700

APPENDIX 5

o	1	2	3	4	5	6	7	8	9	1o	11	12	13	14	15	16	17	1
13.	Plantago lanceolata	-plants with annual hoeing besides crop-rotation.	-	5o-6o	3o-4o	6o-8o	2o-25	-disk -harrow -roller	XI	5-6	5o	o.5-1	-hoed -weeded	when the leaves have 12-14 cm	with sickle	at shadow t° max. 4o-5o°C	dryed leaves (6:1)	1500 2000
14.	Salvia officinalis	-plants with annual hoeing -cereal besides crop-rotation	-	5o-6o each year	4o-5o	6o-7o	28-3o	-disk -harrow	XI	6-8	7o	3-4	-hoed -weeded	leaves during blooming	manual	at shadow t° max. 3o-35°C	dryed leaves (4:1)	600 800
15.	Saponaria officinalis	-plants with annual hoeing -cereal	-	5o-6o	3o-4o	4o-5o	28-3o	-disk -harrow	III	8-1o	5o	2-3	-"-	roots	-"-	at sun	roots (4:1)	800 1200
16.	Sinapis alba	-plants with annual hoeing	-	5o-6o	-	6o-8o	2o-25	-disk -harrow	III	1o-12	25	2-3	-weeded	when the plants are yellow	with sickle	drying selection	seeds	1000 1500
17.	Solanum laciniatum	-plants with hoeing -cereal	-	4o	3o	8o-9o	28-3o	-disk -harrow -roller	III	4	6o	3-4	-hoed -weeded	when the first fruit appears on stem	with sickle at 20 cm high	at shadow t° max. 7o-8o°C	dryed herbs (7-8:1)	2000 2500
18.	Tagetes patula	-plants with hoeing -clean	-	5o-6o	-	7o-8o	2o-25	-disk -harrow -roller	III	4-8 manual,	5o	1-15	-hoed -weeded	when the flowers are completely open	manual	at shadow t° max. 35-4o°C	dryed ligule (7:1)	250 350

APPENDIX 5

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
19.	Thymus vulgaris	- plants with hoeing - cereal besides crop-rotation.	-	60-80	-	80-100	28-30	-disk -harrow -harrow	shoot III plantation : X	0.4 Kg/100m^2	20	0.5-1	-weeded -watered	at the opening of first flowers.	manual with sickle	at shadow t^o max 30-35^{o}C	dryed herbs (4:1)	2000 2500
										-	50 x 20 with 2-3 shoot	-	-hoed -weeded					
20.	Valeriana officinalis	- plants with hoeing - cereal - very clean	-	60-70	50-60	35-40	28-30	-disk -harrow -roller	X-XI	4-6	50	0.5-1	-hoed -weeded	at the end of vegetation	manual with sickle	at shadow t^o max 35-40^{o}C	dryed roots (4-5:1)	1200 1500

APPENDIX 6

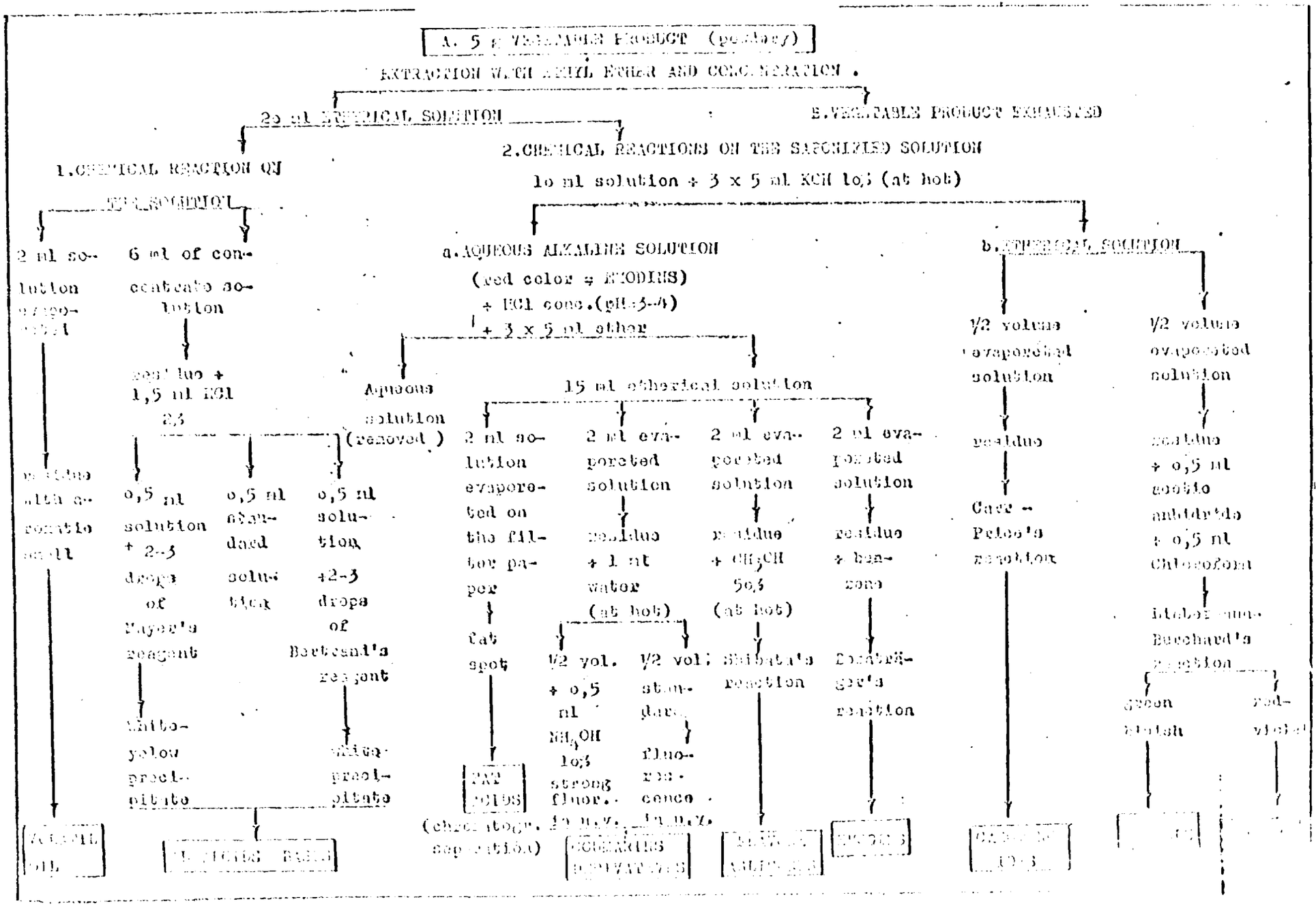
Results of the chemical analyses

No.	Denomination of preparation	Contents in active principles		Alcohol concentration		Dryed residue	
		Indicated in literature.	Existing.	Indicated in literature.	Existing.	Indicated in literature.	Existing.
1.	Tincture Capsici	-	-	63-67%	67%	min 4%	4.25
2.	Tincture Eucalypti	-	-	63-64%	63%	" 2.5 g%	3.9 g
3.	Tincture Stramonii	0.028 - 0.032 g%	0.0288 g%	63-67%	65%	-	-

Quantitative determinations of essential oils

No.	Denomination of plant	Part used	Indicated content min. %	Determined contents %	Obs.-
1.	Foeniculum Vulgare	Fructus	2	1.1	dryed
2.	Coriandrum sativum	Fructus	0.4	0.3	"
3.	Eucalyptus globulus	Folium	1.5	0.6	"
4.	Ocimum camphoratus	Herba	2.5	1	determined 48 hours after collection.
5.	Ocimum basilicum	Herba	-	0.46	"
6.	Cymbopogon citratus	Herba	-	0.9	dryed
7.	Cuminum ciminum	Fructus	-	4.2	dryed

QUALITATIVE CHEMICAL ANALYSIS OF A VEGETABLE PRODUCT (DRIED)



APPENDIX 7

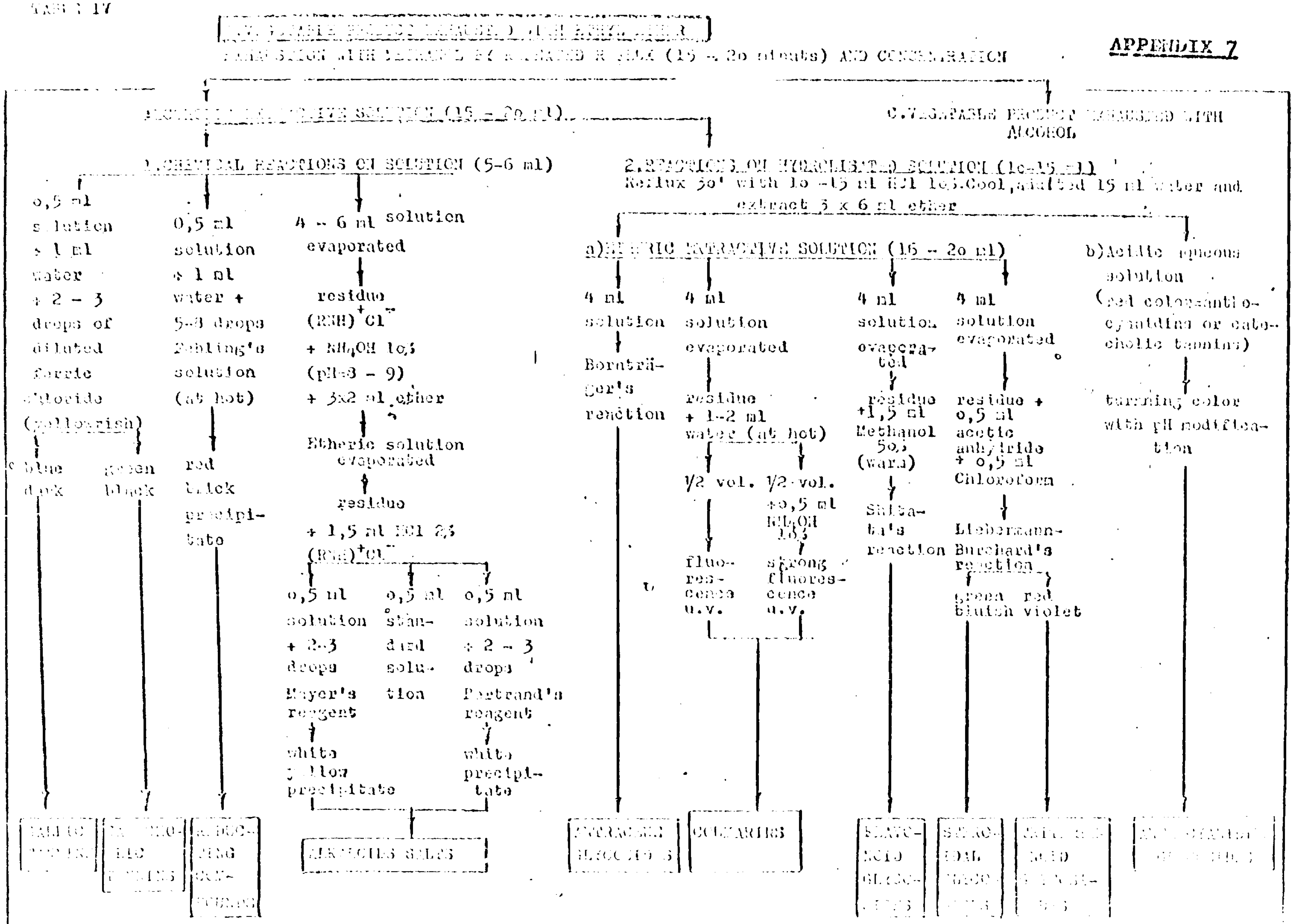
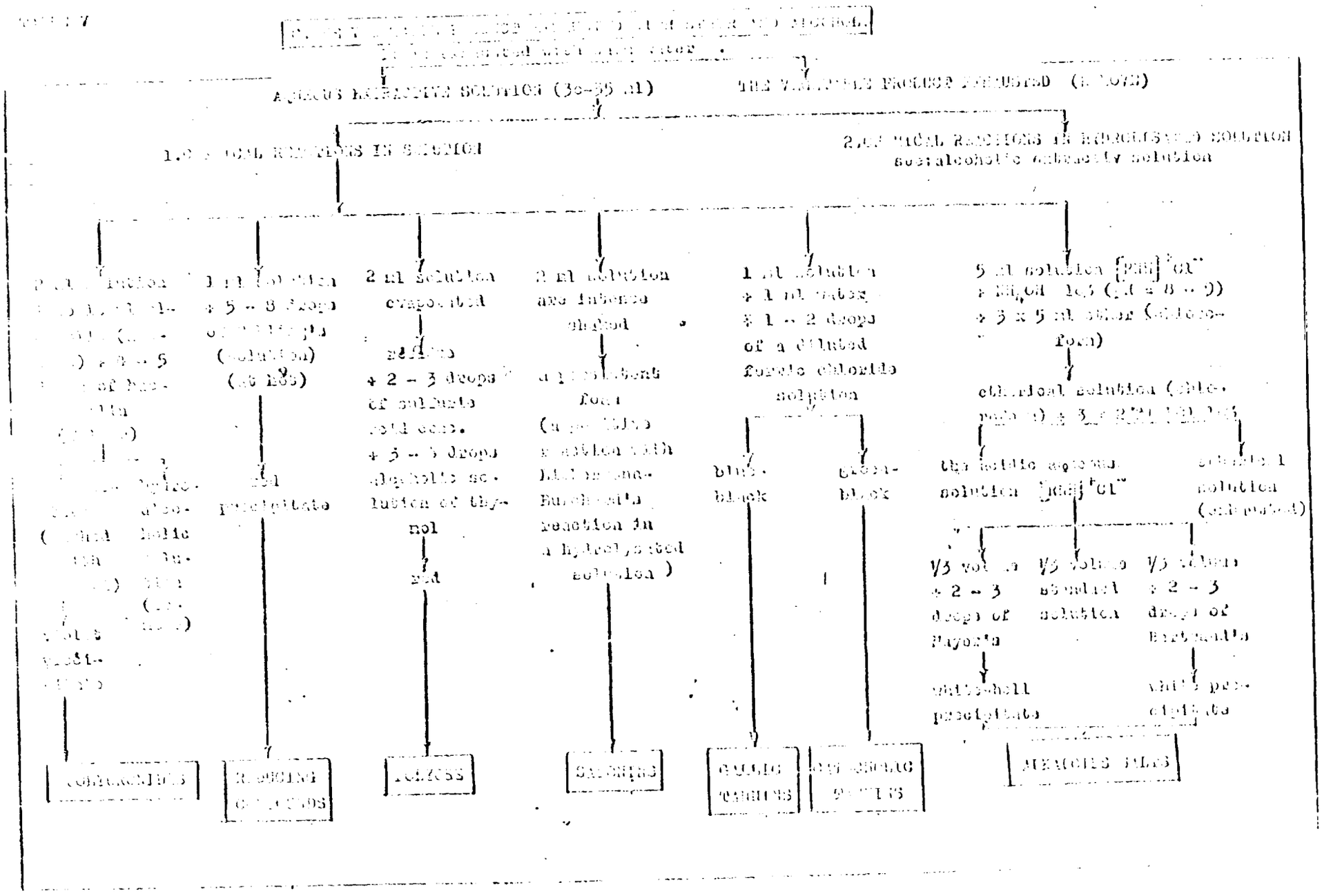


TABLE 17
(15 - 2o minutes) AND CONCENTRATION
(15 - 2o ml)
C.VEGETABLE PRODUCT WASHED WITH ALCOHOL
1.CHEMICAL REACTIONS ON SOLUTION (5-6 ml)
2.REACTIONS ON HYDROLISATED SOLUTION (1o-15 ml)
Reflux 3o' with 1o -15 ml HCl 1o%.Cool,added 15 ml water and extract 3 x 6 ml ether
o,5 ml solution + 1 ml water + 2 - 3 drops of diluted ferric chloride (yellowrish)
blue dark
green black
0,5 ml solution + 1 ml water + 5-8 drops Fehling's solution (at hot)
red brick precipitate
4 - 6 ml solution evaporated
residue
(RNH)+Cl-
+ NH4OH 1o%
(pH=8 - 9)
+ 3x2 ml ether
Etheric solution evaporated
residue
+ 1,5 ml HCl 2%
(RNH)+Cl-
o,5 ml solution + 2-3 drops Mayer's reagent
white yellow precipitate
o,5 ml standard solution
o,5 ml solution + 2 - 3 drops Bertrand's reagent
white precipitate
a)ETHERIC EXTRACTIVE SOLUTION (15 - 2o ml)
4 ml solution
Borntränger's reaction
4 ml solution evaporated
residue + 1-2 ml water (at hot)
1/2 vol.
1/2 vol. +o,5 ml NH4OH 1o%
fluorescence u.v.
strong fluorescence u.v.
4 ml solution evaporated
residue +1,5 ml Methanol 5o% (warm)
Shibata's reaction
4 ml solution evaporated
residue + o,5 ml acetic anhydride + o,5 ml Chloroform
Liebermann-Burchard's reaction
green bluish
red violet
b)Acidic aqueous solution
(red colour-antho-cyanidins or catecholic tannins)
turning color with pH modification
ALKALOIDS SALTS
COUMARINS



APPENDIX 7

PART I

MACROSCOPIC EXAMINATION .

	Cortex (bark)	Folium (leave)	Flores (flowers)	Herba (stem, leaves, flowers)	Fructus (fruit)	Semen (seed)
(aspect)	- Transversal section (determination of the organ relation between the tissues). - The form - Decorticat or not - The fracture (fibrous, clear, smooth, granular, farinaceous) - The consistence	Transversal section (relation between the tissues, mechanical elements). - The form - With or not with suber - The external surface (area) (striates, lenticels, lichens). - The internal surface (striates or flat surface) - The fracture - The consistence	- Leaves with or not hairs, thins or thicks, with petioles or sessiles. The material after maceration: - The form - The border - The nervation (thin leaves).	- Isolated or in inflorescence (Inflorescence type) - Stage of development - Complet or not The material after maceration: - See folium.	Caracterisation of every organ (Cauli, Folium, Flores, Fructus) The material after maceration: - The disposition of the leaves and flowers on the stem	- The type - The form - The consistence - The transversal section (relation between the tissues). - The presence or absence of the seeds.	- The form - The consistence - The transversal and longitudinal section (relation between tegument, endosperm and embryon).
tions	- length - breadth (width) - diameter	- length - breadth - thickness	The material after maceration (thin leaves) Dried material - index leaves - length - breadth (width)	The diameter after moistening	see every organ	- length - breadth - diameter	- on illustrative paper (length, breadth)
The colour of the material	By external and internal after be cuts	The external and internal surface	The dorsal and ventral surface	For the corolla	For every organ	Inner and outward	Inner and outward
and taste	AFTER THE BREAK UP OF THE MATERIAL OR "DROGUM"						

MICROSCOPIC EXAMINATION

[illegible]	Radix (Rhizoma, [illegible])	Cortex (bark)	Folium (leave)	Flores (flowers)	Herba (stems, leaves, flowers)	Fructus (fruit)	Semen (seed)
Transversal, longitudinal, radial and tangential sections.	-Structure type -The disposition of xylem and liber phloem -Characteristic elements and tissues (starch, calcium oxalate, lignified tissues, fibres, stone cells, secretory apparatus, etc).	General aspect (medullary rays, lignified tissues, fibres, stone cells, calcium oxalate, starch, etc).	-The structure of the limb -The fascicle type -Pericycle nature -The secretory apparatus (purses, canals, cells, glandular hairs, latex vessels) -Epidermal trichomes	|	For every organ	- Pericarp structure (mechanic tissues, secretory canals, latex vessels, etc) - For the fruits with seed see Semen	-The teguments' structure (epidermis, mechanical tissue, coloured tissue) -The endosperm's structure -The cotyledons' structure (cellular inclusions)
Powder and cleared "[illegible]" preparate	-Common elements and tissues (fragments of large xylem vessels, reticulate vessels, round bordered pits, scalariform vessels, fragments of cork, fragments of parenchyma) -Characteries elements and tissues (simple fibers or together with crystals, starch, fatty oil, volatile oil, stone cells, calcium oxalate)	-Common elements and tissues (fragments of phloem parenchyma, cortical parenchyma, cork) -Characteristic elements and tissues (simple fibers or together with crystals, stone cells, fragments of parenchyma, calcium oxalate, starch)	-Common tissues (fragments of chlorophyllian tissue, spiral vessels, annular, rare reticulate small vessels, epidermal fragments) -Characteristic elements and tissues (type of stomate, striated cuticles, epidermal trichomes and glandulars, simple fibers or with crystals)	-Common elements and tissues (fragments of tissues, papilla, pollen, xylem vessels, epidermal fragments) -Characteristic element (hairs, glandular hairs, calcium oxalate, fibers stone cells, pollen's membrane)	For every organ	-Common tissues (fragments of epicarp, small vessels, fragments of mesocarp with volatile oil, fat oil) -Characteristic elements (fibers, stone cells, hairs, calcium oxalate, starch, pigmentary cells)	-Common tissues (fragments of cotyledon, of endosperm with fat oil and aleurone, small vessels) -Characteristic elements (fragments of pigmentary tissues, fibers, stone cells, calcium oxalate, starch)

APPENDIX 8

L i s t

of the pharmaceutical products prepared by the UNIDO experts in Sudan

1. Tea for stomach colics at children contains :

- Flores Chamomillae - 3 gr.
- Folium Menthae - 1 gr.
- Fructus Foeniculi - 4 gr.
- Fructus Coriandri - 2 gr.

Effects: Antispasmodic and intestinal disinfectant.
Indications: The tea can be used for the treatment of stomach and intestinal colics at children and suckers.
Side effects: None.
Dose : To be used as 1% infusion, twice a day 50 ml adding some sugar. -

2. Laxative tea

contains :

- Folium Sennae Sine Resina - 10 gr.
- Tea (Folium Theae) - 10 gr.
- Anhydre sodium sulphate - 6.6 gr.

Effects: Laxative and excitant of the large intestin. peristaltism.
Contraindications: It is not to be used in case of intestinal spasms, by the pregnant women and the new born children.
Dose : A full spoon 200 - 300 ml hot water and than the pot is covered and after 30 minuts the tea is filtered, adding sugar.

3. Antirheumatics solution

contains :

- Essential oil of mint - 1 gr.
  (or mentolum 0.5 gr)
- Acetic ether (Ethyl acetate) - 4 gr.
- Ethylic alcohol 95° -40 gr.
- Water -55 gr.

Effects: Revulsive and analgesic.
Contraindications: Children under 2 years old should not use it
Dose : Local embrocation.

4. Antirheumatics and revulsive solution

contains:

- Capsicum tincture - 10 gr.
- Clorophorm - 5 gr.
- Ethylic alcohol 95° - 35 gr.
- Water - 50 gr.

Effects: Revulsive and analgesic, locally, antirheumatics.

Contraindications: It should not be used on irritated skin.

Administration: Local embrocations.

5. Capsicum tincture

contains:

- Fructus Capsici - 100 gr.
- Ethylic alcohol 70° q.s. add. 1000 gr. tincture.

Effects:

- Internal: digestive stimulus and against the abdominal gas accumulation.
- External: Antirheumatics.

Contraindications: - Internal : Not to be used in stomach affections (ulcer)
- External : Not to be applied on the irritated skin.

Dose: - Internal : 10-20 drops twice a day
- External : Embrocation 50% tincture and 50% water.

6. Eucalypti tincture

contains:

- Folium Eucalypti - 200 gr.
- Ethylic Alcohol 70° q.s. add. 1000 gr. tincture.

Effects: Light disinfectant for lungs, stimulates bronchitis secretion and expectoration. On mucous membranes it has a light astringent and antiseptic effects.

Indications: To be used as respiratory antiseptic in chronic bronchitis, dried rinofaringitis and sinusitis.

Dose : Adults : 2 gr (45 drops) on sugar - 3 times a day max. dose 10 gr/day.

Children: 0.2 gr/each year old x 3 times a day, on sugar

7. Solution for mouth disinfection

contains :

- Eucalypti tincture - 80 gr.
- Phenol - 5 gr.
- Menthol - 1 gr.
- Ethylic alcohol 95° - 10 gr.
- Water - 5 gr.

Effects: Antiseptic of bucal cavity. To be used in the treatment of faringitis, laringitis and stomatitis.

Contraindications: Children should not use it.

Dose : 10 drops in a glass of water for mouth disinfection.

8. Daturae tincture

contains:

- Folium Datura - 100 gr.
- Acidum hydrochloricum dilutum - 10 gr.
- Alcohol aethylicus 70° q.s. add. 1000 gr. tincture.

Effects: Sedative and antiseptic, it reduces secretion and intestinal peristaltism as well as the spasms of bronchi. It is recommended against spasms of intestina smooth muscles, asthma, hooping-cough and epilepsy.

Contraindications: Not to be used by the pacients with constipation, glaucoma and prostatism.

Dose : Adults : 0.5 ml (25 drops) on sugar 3 times a day.

Children: - under 1 year : 1 drop 3 times a day
- 1-2 years : 2 drops 2 times a day
- 3-5 years : 3 drops 3 times a day
- 6-10 years : 5 drops 4 times a day
-11-15 years : 10 drops 3 times a day

Maxime dose : 1.5 gr once, 5 gr. per 24 hours.

9. Anticoughing solution

contains :
- Daturae tincture - 10 gr.
- Bromophorm - 10 gr.
- Natrium benzoicum - 1 gr.
- Codeine - 0.8 gr.

or

- Codeinum phosphoricum - 1 gr.
- Eucalypti tincture - 10 gr.
- Alcohol aethylicus 95° - 65 gr.
- Water - 5 gr.

APPENDIX 8

Effects : Sedative for coughing and disinfection of respiratory system. To be used against hooping cough and irritate coughing.

Contraindications: Children under 3 years and patients with cardiac and kidney serious affections should not used it.

Dose : Adults : 15 drops 3 times a day with tea.
10 drops 2 times a day with tea.

10. Sedative syrup for children

contains :

- Natricum bromatum - 1 gr.
- Calcium Bromatum - 2 gr.
- Daturae tincture - 1 gr.
- Syrup - 30 gr.
- Water + preserving agent add. 100 gr.

Effects: Sedative and antispasmodic. It allows a deep sleep. Children with agitations, sleeplessness, infantil asthma and convulsive coughing can use it.

Side effects : None.

Dose : Children : 1 year - 1 tea-spoon per day
2 years - 1½ " " "
3 " - 2 " " "
4 " - 3 " " "

APPENDIX 9

List of Laboratory Equipment Required for Medicinal & Aromatic Herbs Research Unit, National Council for Research

No.	I t e m	Quantity
1.	Apparatus for determination of essential oils (Lighter than water & Heavier than water)	2
2.	Vacuum pump assembly	1
3.	Digital Densimeter	1
4.	Digital polarimeter	1
5.	Laboratory cooler for water circulation	1
6.	PH - Meter	1
7.	Mechanical stirrer (agitator)	1
8.	Microburettes (10 ml)	5
9.	Burettes (25 ml)	10
10.	Laboratory centrifuge	1
11.	Round bottom flask (100 ml)	25
12.	Analytical balance	1

Total estimated cost including 15% transport $ 7,800.000.-

APPENDIX 9

List of the Pilot Plant Equipment for Extraction & Distillation of Medicinal and Aromatic Plants

No.	I t e m	Quantity
1.	Extractor (percolator); cap.: 30 l., material : Stainless steel	1
2.	Extractor with mechanical stirrer (agitator) at atmospheric pressure; Cap.: 100 l., material : stainless steel	1
3.	Manual Filter press; Cap.: 30 Kg	1
4.	Concentrator for extracts with vacuum pump and refrigerator; Cap.: 20 l., Electrical heating, material : stainless steel	1
5.	Distillator for essential oils with refrigerator, florentin vessel and electric heating; Cap.: 100 l., material: stainless steel	1
6.	Receiver and sedimentation vessel for extraction solutions; Cap.: 50 l., material ; stainless steel	1
7.	Pipes, Fittings and Taps.	

Total estimated cost including 15% transport $ 37,000.000

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

PROJECT PROPOSAL

Part A : Basic Data

Country: Sudan

Project No:

Scheduled Start: May 1980

Scheduled Completion: 1981

Origin & Date of Official Request:

Government Counterpart Agency:

Proposal Submited By :

Date of Submission:

Project Title : "Assistance programme for the evaluation of Medicinal & Aromatic Plants which could be used to formulate pharmaceutical preparations".

Unido Contribution:

Government Contribution:

Funds Requested From Unido:

Input : $ 127,500,000

Convertible$ 127.500,000

Others : $

Unido Substantial Backing Section: The Chemical Industries Section

Programme Component:

Code :

PART B

1. BACKGROUND & JUSTIFICATION

The development of traditional medicine based on available medicinal plants in developing countries is one of the most important programmes of UNIDO. Similar projects have been designed for several developing countries and some of them are already implemented.

Many of the developing countries have their own systems of medicine, and large segments of their population still depend upon traditional remedies. Due to the increasing demand on medicaments in the whole world, especially in developing countries, it is essential to start production of established traditional remedies and to include them in health care programmes in those countries.

Sudan is among the developing countries that have a variety of important plants, for which there is a demand on the international market, and rich with flora that is a potential source of new drugs and new biologically active substances. The processing of those plants into semi-finished form for export or the production of established drugs from them to meet demand within the country, should be promoted.

During November, 1979 UNIDO organized a mobile unit under the project RP/RAF/79/005, which visited Sudan in order to collect samples of medicinal and aromatic plants for quantitative & qualitative determination of active principles as well as demonstration of the possibility to prepare locally pharmaceutical preparations based on these active principles in cooperation with locally available specialists.

Medicinal & Aromatic Herbs Research Unit, the National Council for Research, Khartoum - Sudan, was the focal point and the centre of activities of the mobile Unit. The results obtained and the pharmaceutical products prepared have proved the possibility to set up a pilot production unit to produce pharmaceutical preparations based on raw materials available in the Sudan, under

the condition to a further assistance programme.

2. OBJECTIVES :

2.1 Development Objectives: The programme will lead to the establishment of a national extraction and distillation Unit of Medicinal & Aromatic Plants available locally.

Furthermore, the extracts could be used to formulate pharmaceutical preparations which could be included in health care programme in the country. Such efforts would help Sudan with its expanded national health programmes, improve its economics and create employment opportunities.

2.2 Immediate Objectives:

a) Transfer of technology and supply of equipment and planting material, in order to facilitate and accelarate the establishment of a pharmaceutical industry based on medicinal plants.

b) Training of technical personnel.

3. PROJECT OUTPUTS

Government policy on the development of a pharmaceutical industry based on medicinal and aromatic plants available.

Survey of the quality and quantity of natural resources in this field.

Development of research work on medicinal & aromatic plants and their utilization in the pharmaceutical industry.

4. PROJECT ACTIVITIES:

The main activities of the project are the following:

4.1 Training of the local personnel in the field of cultivation and processing of medicinal & aromatic plants to formulate pharmaceutical preparation from them. UNIDO will organize a training course in a country with experience in the field of processing of medicinal plants and their use in the pharmaceutical

industry during 1980.
(4 Fellowships (Botanist, agronomist, phytochemist and Technologist for 3 weeks).

4.2. International experts for local training of the Sudanese specialists in this field, which is designated to develop and accelarate the research and production activities of pharmaceuticals based on medicinal plants
(3 experts: one agronomist for 6 months - August to January; one analyst for 3 months - after the delivery of lab. equipment, see item 4.3; and one technologist for 6 months after the delivery of the pilot plant equipment and overlaped with the analyst stay period, see item 4.4.).

4.3. The equipment of Medicinal & Aromatic Herbs Research Unit Laboratories with necessary apparatus and materials.

4.4 Establishment of a pilot production Unit by supply of necessary equipment for extraction and distillation of active principles from medicinal & aromatic plants.

5. PROJECT INPUTS :

5.1. The UNDP contribution will be the following :

5.1.1.	Fellowships for 4 Sudanese specialists to be trained in the country appointed by UNIDO during 1980. 4 Fellowships X 2 month	Estimated costs : $ 15.200,000
5.1.2.	International experts for local training of the Sudanese specialists (3 experts during 1980/81) (6+3+6) month X 4.500,000	67.500,000
5.1.3.	Supply of laboratory equipment (see appendix 3)	7.300.000
5.1.4.	Supply of pilot plant for extraction and distillation of active principles from medicinal & aromatic plants (see appendix 4)	37.000,000
	T O T A L	L27.800.000

5.2. The National Council for Research (Medicinal & Aromatic Herbs Research Unit) will make available:

a) Necessary space (room or hall) for the setting up of the pilot plant including services (water, electricity ..... etc.).

b) Local personned for the laboratory work and the operation and running of the pilot plant.

c) Raw materials (medicinal plants)and ingredients for the preparation of pharmaceuticals based on them.

5.2.3. Equipements pour l'unité pilote d'extraction et de distillation des principes actifs et appareils de laboratoire (Voir l'Annexe VII).... 85.600

Total général: 163.000 $