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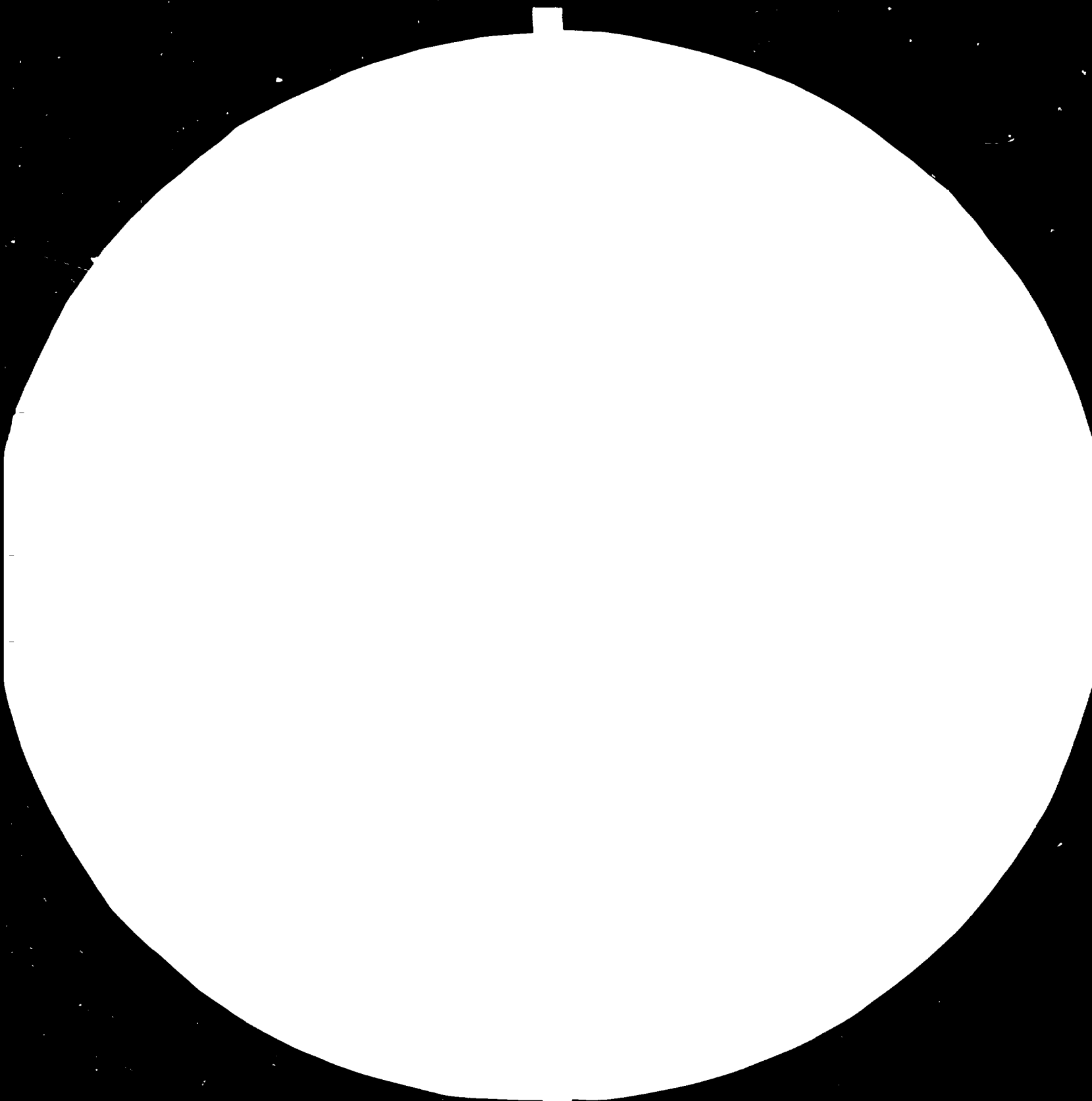

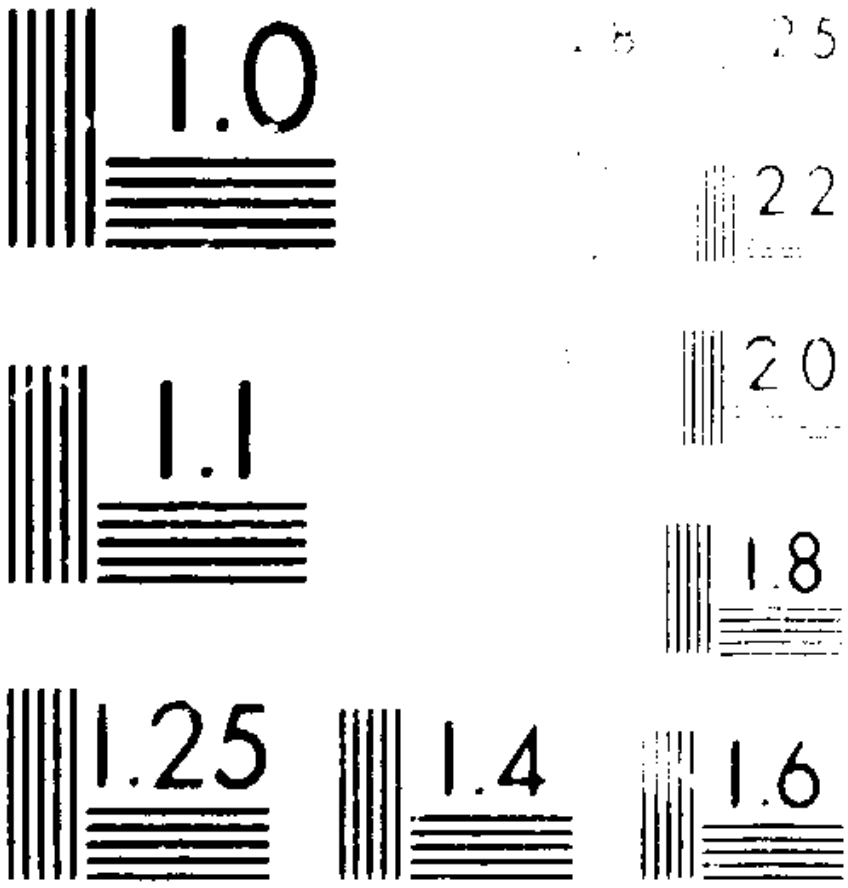
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UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Botswana.

SURVEY OF THE POTENTIAL FOR PLANT-DERIVED PHARMACEUTICALS AND MEAT BY-PRODUCTS

RP/BOT/82/001

BOTSWANA

Terminal report *

Prepared for the Government of Botswana
by the United Nations Industrial Development Organization

Based on the work of Dr. E. Paun,
Expert in the Evaluation of the Potential for the
Utilization of Medicinal and Aromatic Plants

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T A B L E O F C O N T E N T S

INTRODUCTION

The Republic of Botswana represents a large territory, of 582.000 km^2, with an elevation between 500 and 1200 m, which is composed in the biggest part of the Kalahari desert. The population of the country is very reduced (1,78 inhabitants/km^2) and the majority is concentrated in the most favorable pedoclimatical zones, situated in the Eastern Region.

The territory of the Republic of Botswana consists of large areas of savannah forests, table-lands, hilly regions and Okavango delta in the North. This territory, characterizated by very different pedoclimatical conditions, is convered with a varions flora in which we find many medicinal and aromatic species which are not used yet. Many species are used by folk medicine and some of them are exported (Harpagophytum procumbens).

I. NATURAL RESOURCES

1. Spontaneous flora

The information in the report is based on:

- the UNIDO -Expert's own experienced obeservation during the previons and present trips (in Tsabong, areas North of Gaborone, Lobatse, Kanye, Molepolole, Moshupa, Mmankgodi, Manyana);
- on considerable literature about grasses, herbs, trees, shrubs and poisonous plants growing in Botswana;
- and with assistance from Mr.Kwerepe (Ecologist - Ministry of Agriculture), Miss.Pearl Motsepe (Botswana Agriculture College) and Miss Helen Moss (Botanist - Veld Products Project - Gabane).

The UNIDO expert found that in this country there are 3 groups of medicinal and aromatic plants.

1.1. The first group includes 12 medicinal and aromatic species growing in sufficient quantities in the spontaneous flora of Botswana (Appendix 1).

It is possible to used directly these medicinal and aromatic species because they were studied and they were recognized by international pharmacepoeia.

1.2. The second group includes 42 medicinal and aromatic species which are groving in the spontaneous flora of Botswana, used as folk medicines and which must be tested from therapeutical point

of wiew. These species could substitute the species of the same genus which are recognized by international pharmacopoeia, but which do not occur in Botswana. (Appendix 2).

These group of plants have been insufficiently or are totally untested, but there are reliable indications that some of them are valuable from the pharmaceutical point of view.

The studies have been started with some wild species:

- Balanites aegytiaca - for solasodin - for corticosteroide hormons
- Solanum incanum - for solasodin - for corticosteroide hormones
- Argemone mexicana - for morphin - sedative
- Asclepias fruticosa - for glicosides - cardiotonic

1.3. The third group includes 29 medicinal and aromatic species growing in the spontaneous flora of Botswana that are used in folk medicine and which must be tested for therapeutical values.

Many of these species have a content of alkaloides, glicosides, flavonoides and it may be possible to used them for pharmaceutical products. Some of them contain essential oils and can be used in cosmetics, perfumes, soaps, toothpastes and in the detergents industries. (Appendix 3).

Most of the indigenous Botswana plant species included in this report can be harvested in commercial quantites for the preparation of the pharmaceutical products and tp obtain essential oils.

1.4. Samples of plants

In two months the expert collected 27 samples of medicinal and aromatic plants which are growing in the spontaneous and cultivated flora of Botswana.

Same of these samples were analized in the phytochemical laboratory of the Medicinal and Aromatic Plants Experiment Station and in the laboratory of the Faculty of Pharmacy in Romania.

2. Cultivated flora

2.1. Medicinal and aromatic plants are not deliberately cultivated in Botswana for medicinal purposes but certain species

of pharmaceutical importance are cultivated for decorative and other purposes, for example:

- Vinca rosea (antileuchaemia) which is cultivated as a decorating flower.

- Eucalyptus globulus (antibronchitis) which is cultivated for wood, and

- Capsicum annum (antirheumatic) which is cultivated as a spice plant.

2.2. The expert brought and handed to Mr.Kwerepe 29 medicinal (Range Ecologist - Ministry of Agriculture) and aromatic species cultivated in Europe. Of these, only 24 species were sownd, because the pice land allocated (in Agricultural Station Sebele) for this research (under irrigation conditions) was to small, having only 17 m long and 9 m wide = 4 square meters for each species. Of the 24 species sowed by the expert only 11 species were noted to germinate before the departure of the expert (27.11.82), but the return of the expert, for the second phase of the mission (15.03.83), only the following 4 species were in well established viz. Datura innoxia, Ocimum basilicum, Plantago lanceolata and Althea rosea var.nigra. Concerning the others species: Hyocyamus niger, Calendula officinalis, Salvia sclarea, Tagetes patula and Cynara scolymus the expert observed that most had died, though only 2 or 3 very small plants were surviving. (Appendix 4). This situation was caused by the prolonged drought and incorrect and insufficient irrigation (the pump for irrigation was brocken down two weeks - Mr.Frederik Morwe). Unfortunately Mr.F.Morwe failed to record certain observations which were requested by the UNIDO-Expert. (Appendix 6).

3. TRAINING OF LOCAL PERSONNEL

3.1. For the spontaneons flora

During the trips, to harvest the samples, the exper was accompanied by Mr.Kwerepe, Miss Helen Moss, Mr.Motshwara Lemo and Mr.T.S.Mollentze. In addition the expert went in the field where he taught Mr.Motshwara Lemo (Gaborone) and Mr.T.Rara Metenge (Francistown), accompanied by 2 filed assistants, concerning the methodology of mapping and quantitative determination of medicinal and aromatic plants which can be harvested annually.

The methodology, translated in English, was handed, to Mr.Kwerepe (Ecologist; Ministry of Agriculture) on the departure of the expert.

3.2. For the cultivated flora

The expert toghether with Mr.Frederick Morwe and 3 workers, carried out the following :

- soil preparation, rowmarking and sowing of the 24 species at 15.11.1982.

The expert prepared and handed to Mr.F.Morwe or to his collaborator, Mr.Andrew Moroko, the following:

- the main elements of cultivation technology (Appendix 5);

- the observations to be made during the vegetation period (Appendix 6).

- the expert also prepared and presented a document on the method of preparing of teas of some cultivated medicinal and aromatic plants. (Appendix 7).

4. LABORATORY ACTIVITY

4.1. For the medicinal plants

The samples, colected by UNIDO - Expert, were analized by Chemist Anca Hnagiu and Chemist Rodica Lupeanu of the Medicinal and Aromatic Plants Experiment Station - Fundulea and Prof.Liviu Ciulei and Dr.Albulescu Doina of the Faculty of Pharmacy - Bucharest, in Romania.

The qualitative content (Appendix 8) indicates the posibility to obtain substances, some of them very important for pharmaceutical industry for instance: steroids, flavones, polyphenols, polysacharides, rezines, tannins a.s.o.

The quantitative content of some medicinal plants establis hed is accepted or superior compared with the minimum content indicated in the technical literature (Appendix 9).

4.2. For the aromatic plants

The most of the aromatic plants have good or very good content of essential oil. (Appendix 10).

The lower content of essential oil in some of the samples could be explained by the unfavorable period in which the collection was done.

II. FINDINGS

1. In the spontaneous flora of Botswana are growing a lot of medicinal and aromatic plants, which are not investigated from a therapeutical point of view. These species can offer the opportunity to identify some active principles useful for the pharmaceutical products industry and the essential oils which are recommended for the pharmaceutical products too and for the soaps, cosmetics and detergent industries.

2. There are not data available for the quantity and quality of medicinal and aromatic plants from spontaneous flora which can be harvested annually without disturbing the ecological system. Some information about quantity of some medicinal and aromatic species, can be obtained from the final report made by Miss Helen Moss and Mr.F.Taylor. Miss Helen Moss established the density and distribution of the most species included in this report in 83 points of the most important regions, during about 18 months period. (Appendix 11).

3. There is not any organization specialized in the exploitation of the spontaneous flora, in the introduction in culture of new medicinal and aromatic species or in the processing of medicinal plants for pharmaceutical purposes, excepting "Veld Products Project" recently researched by Mr.Frank Taylor.

4. All medicines and pharmaceutical products prepared by medicinal and aromatic plants are imported (tincture of capsicum, tincture of stramonium).

5. There is not special laboratory organized for the study of medicinal and aromatic plants.

III. RECOMMENDATIONS

III. A. FOR MINISTRY OF AGRICULTURE

1. I recommend to the Ministry of Agriculture to set up a unit specialized in the valorisation of medicinal and aromatic plants.

The main objectives of this unit have to be the following:

- identification of the valuable species growing in the spontaneous flora of the country;

- evaluation of the quantities of plants which can be harvested yearly without disturbing the ecological system;

- in cooperation with Botswana Agricultural College (in the future: Botswana Agricultural Faculty), to issue some guides (leaflets) describing the plant, the parts of the plant to be harvested, with drawings in the vernacular language to guide the harvesters.

2. I recommend to the Ministry of Agriculture, through Departament of Agricultural Research, to coordinate and to hold Botswana Agricultural College in the biological research for spontaneous flora in Botswana.

The main objectives of this unit have to be the following:

- to have a collection of medicinal and aromatic species which are growing in Botswana, recognized and nonrecognized by international pharmacopoeia but used in the folk medicine;

- to have lessons for students, in the last year of study, about medicinal and aromatic plants;

- to help the specialized unit from the Ministry of Agriculture in identification and evaluation of the quantities of plant (to use the students during holiday period).

3. I recommend to the Ministry of Agriculture, through Departament of Agricultural Research (Sąbele), to organize the Agrobiological Research for cultivated flora.

The main objectives of this unit have to be the following:

- to maintain a collection of medicinal and aromatic plants which do not grow in Botswana (50-100 m^2);

- to try to introduce, in culture, the most important and necessary species for Botswana.

III.B. FOR MINISTRY OF COMMERCE AND INDUSTRY

I recommend that the "Veld Products Research" (recentely researched by Mr.Fr.Taylor) should develop this project on medicinal and aromatic plants.

The main objectives of this unit have to be the following:

- to organize a network for the harvest of the useful parts of the plant and their conditioning as well as the transport

- to contract some cultivated medicinal and aromatic plants;

- to process all these plants (to break up, to pack up, to store);

- to prepare the simple (one plant) and the combined (two or more plants) teas;

- to produce essential oils;

- to produce pharmaceutical products (tinctures, syrups, extracts, tablets);

- to sell all these products (pharmacy, hospitals, for export).

III.C. FOR MINISTRY OF HEALTH

I recommend to the Ministry of Health to set up a Research laboratory to study the medicinal and aromatic plants and the all products made by "Veld Products Project".

The main objectives of this unit have to be the following:

- to make, the phytochemical analysis, for every plant products (leaves, herbs, flowers, fruits, bulbs);

- to make the pharmaceutical analysis for every final products prepared by "Veld Products Project";

- to study the folk medicine.

The great majority of phytochemical analysis methods are described in pharmacopoeia.

x

x x

EACH ONE OF THE MENTIONED MINISTRYS MUST TO ENSURE THE LOCAL SPECIALIST (1-2 BOTANIST (S) OR BIOLOGIST (S) AND 2-3 CHEMISTS OR PHARMACIST AND THE NECESSARY SPACE WITH WATER, ELECTRICITY A.S.O.

x x

x

III.D. FOR UNIDO

Pending of the positive settlement of the recommendations mentioned at the para III.A; III.B and III.C the UNIDO can do the following:

1. To organise the training programmes (3 months) in a country with large experience in the valorization of medicinal and aromatic plants, for the local specialists, who will work in the field of medicinal and aromatic plants valorization as botanist or agronomist, analyst (pharmacist or chemist for chemical determinations) and technologist (pharmacist or chemist) for the preparation of medicines based on medicinal and aromatic plants.

2. To equip with the minimum and indispensable apparatus the analysis laboratory, that will be set up within the Ministry of Health. (Appendix 12).

3. Assistance of an international expert as analyst, to organize the research laboratory and to train the local personnel to carry out the chemical determinations of active principles, for a period of 6 month.

4. To ensure the necessary equipment for setting up a distillery and the indispensable apparatus to acquire pharmaceutical products from medicinal and aromatic plants. (Appendix 13)

5. Assistance of an international expert as technologist to supervise the erection, mounting and installation of the distillery and pharmaceutical equipment and to train the local personnel to prepare pharmaceutical products based on medicinal and aromatic plants, for a period of 6 month.

Appendix 1

List of medicinal and aromatic plants growing in sufficient quantites in the spontaneons and cultivated flora and recognized by international pharmacopoeia

No	Botanical name	Part of the plant used	Distribution	Extant quantitye	Content	Therapeutical effect
1	Acacia senegal	gum	N-E Ghazi	S.q-M.q	arabinic acid (arabinoz) enzime	To prepare pharmaceutical oroducts
2	Capsicum anum	fruits	cultivated	-	capsaicin, capsantin, capsarubin, acids (ascorbic, malic, citric vitamins (B_1, B_2)	revulsive rubefiant antirheumatic
3	Chenopodium ambrosioides	herbs		S.q-M.q	essential oil ascaridol	antihelminthic
4	Datura innoxia	leaves (herbs)	cultivated lands, widespread S-E Botswana	M.q-B.q	alcaloides (scopolamine)	nervous, depressant antispasmodic, antiparkinson
5	Datura stramonium	leaves (herbs)	cultivated lands, widespread	M.q-B.q	alcaloides (atropine, hyoscyamine, scopolamine)	nervous depressan antispasmodic, antiparkinson
6	Eucalypthus globulus	leaves	cultivated	S.q	essential oil eucaliptole pinene, camfene, terpineole	antibronchitis
7	Harpagophytum procumbens	bulbs	Sandy soils	M.q-B.q	-	antireumathic antitumopous

Appendix 1 c

No	Botenical name	Part of the plant used	Distribution	Extant quantity	Content	Therapeutical effect
8	Harpagophytum peglerae	bulbs	Sandy soils	-	-	antirheumathic antitumorous
9	Ocimum canum	herbs	Riverine S.q		essential oil (camphor)	analeptic cardiac, antirheumathic
10	Ricinus communis	seeds	Disturbed ground B.q All over Botswana		fat oil, triricinolein, ricine, ricinine, lipaze	purgative soap industry, airplane oil
11	Strophantus kombe	seeds	Woodland	-	heterosides carditonics (strophantinin)	cardiotonic
12	Vinca rosea (Catharanthus roseus) (cultivated)	herba	Cultivated V.s.q		alcaloides (vincaleucoblastin)	antileuchaemia

Legend: Bq = big quantity
Mq = medium quantity
Sq = small quantity
VSq= very small quantity

Appendix 2

List of medicinal and aromatic plants which are growing in the spontaneus flora, used by folk medicine and which to be tested from therapeutical point of view. (to substitute the species recognized by international pharmacopoeia)

No	Botanical name	Distribution	Extant quantitys	Substitute of the species	Active principles	Therapeutical effects
1	Aloe marlothii Aloe rubreolata Aloe spinosa Aloe zebrina	Wide-spread genus	S.q-M.q S.q-M.q M.q M.q	Aloe ferox Aloe vera Aloe perryi	aloe-emodol aloin acids(cumaric, cinamic, acetic)	tonic-stomachic laxative purgative
2	Andropogon amplectens	On shallow soils	M.q	Andropogon nardus	essential oil (geraniol, citronelal)	stomachic carminativ, antispasmodic
3	Argemone mexicane Argemone subfusiformis	Disturbed ground S-E and N Botswana	S.q M.q	Papaver somniferum	morphine	sedativ
4	Artemisia afra	Throughout Botswana	S.q	Artemisia cina	santonine, essential oil, (cineol, pinen, terpineol)	antihelmintic
5	Balanites aegiptyaca	Woodland, riverine	V.S.q	Solanum laciniatum	solasodine	corticosteroides
6	Cassia abrus " abreviata " biensis " falcinella " italica "kirkii " obovata	C.abreviata: E.Botswana Wooded grassland C.italica Woodland SE	M.q	Cassia angustifolia Cassia acutifolia	emodins, reina, senozid A senozid B	Laxativ purgativ
7	Cymbapogon excavatus Cumbapogon plurinoides	In savana grassland areas	M.q-S.q M.q	Cymbopogon citratus	essential oil (citronelal)	carminativ antispasmodic

No	Botanical name	Distribution	Extant quantitys	Substitute of the species	Active principles	Therapeutical effects
8	Dioscorea dumentorum	Forests	M.q	Dioscorea polystachya Dioscorea giraldii	diosgenine	corticos - teroides
9	Euphorbia candelabrum " heterophylla " ingens " tirucalli	Chobe district	- - S.q M.q-B.q	Euphorbia resinifera	euphorbon	nervous and cardiac stimulant
10	Gonphocarpus fruticosus (=Asclepias fruticosa)	Throughout Botswana	B.q	Digitalis lanata Digitalis purpurea	lanatoside A, B, C purpurea glicozide A, B	cardiotonic
11	Hyphaene benguellensis " natalensis	Riverine sites	M.q	Fraxinus ornus	mannitol manose	purgativ
12	Lobelia erirus	Palapye	S.q	Lobelia inflata	alcaloides (lobeline)	breathing-stimulant, antiasmatic
13	Rhus glauca " lancea " leptodictya " marlothii " pyroides " tenuinervis	R.tenuinervis: Mixed woodland	V.S.q S.q-M.q S.q-M.q S.q M.q B.q	Rhus aromatica	tannin	astringent, desinfectant. hemostatic
14	Salvia africana	Riverine	V.sq	Salvia officinalis	essential oil (tuion, camphor, borneol, tuiol)	carminativ, desinfectant
15	Solanum incanum " panduriforme	Disturbed sites	B.q S.q	Solanum laciniatum	solasodine	corticos-teroides
16	Strychnos cocculoides " madagascariensis " pungens " spinosa	Wooded grassland	S.q - M.q M.q	Strychnos castelanaei Strychnos toxifera Strychnos gubleri	curarine curine	to relax the muscles (in surgery)

No	Botanical name	Distribution	Extant quantity	Substitute of the species	Active principles	Therapeutical effect
17	Urginea altissima " sanguinea	Kpetlang district		Urginea maritima (=Scila) maritima)	cardiotonic heterozides, scillarene A scillarene B	cardiotonic diuretic

Legend: B.q = big quantity
M.q = medium quantity
S.q = small quantity
V.s.q = very small quantity

Appendix 3

List of plants growing in the spontaneous flora in BOTSWANA, used in the folk medicine and which to be tested from therapeutical point of view

No	Botanical name	Part of the plant used	Composition	Folk medicine use for
1	Adansonia digitata	leaves seeds fruits bark	-ascorbic, tartric, citric, malic acids -mucilage, proteine, adansonin	dysentery, astringent, diaphoretic, expectorant
2	Bauhinia petersiana (B.macrantha)	tuberous	-tamin	galactagoge
3	Colophospermum mopane	seeds leaves	-tannin	syphilis, purgativ
4	Combretum sp.	fruits	-	antischistosomiasis (bilharzioses) antimalarial
5	Conyza sp.	leaves	-essential oils	fever, colds, coughs
6	Croton gratissimus	leaves	-essential oil (calamus) crotin	fever, rheumatic, dropsy., pleurisy
7	Croton megalobotritis	bark	-toxalbumin	antihelmintic
8	Elephantorrhiza burkei	root bark	-	astringent
9	Gloriosa superba	root stock	-superbine gloriosine to substitute colchicine	-
10	Helichrysum zeyheri	herbs	-essential oil helecrysin	-
11	Hibiscus furcatus	leafy stems	-	antischistosomiasis (bilharzioses)

Appendix 3 a

No	Botanical name	Part of the plant used	Composition	Folk medicine use for
12	Iboza brevispicata	leaves	-essential oil	-
13	Iboza riparia	leaves	-essential oil	coughs, stomachic, dropsy, expectorant ague
14	Jatropha zeyheri	tuberous	-tanin	"blood purifier", purgativ, headache
15	Lantana camara	leaves	-essential oil (citral) lantanin (lantadene)	coughs, colds, rheumatism
16	Lantana rugoza	leaves	-essential oil lantanin	bronchid affection, galactagoge
17	Lippia javanica	herbs	-essential oil (ocimen)	coughs, colds, measles, urticaria, malaria, dysenterie
18	Lippia scaberrima	herbs	-essential oil (lippianol)	stomachic, tonic, haemostatic
19	Lippia rehmanni	twigs	-essential oil	
2o	Myrothamnus flabellefolius	sumitates	-	colds, backache, haemorhoides, dysmenorrhaea
21	Notholaena eckloniana	leaves	-essential oil sterols, tannine, flavonoides	colds
22	Peltophorum africanum	root bark	-tannin	antihelmintic diarrhoeas dysenteries
23	Plumbago zeylanica	leaves root	-essential oil plumbagin	antileprosy, rubefacient, vesicant, diuretic, suderific
24	Pterocarpus angolensis	seed root	-tannin muningen	to inflamed skin, gonorrhea, intestinal worms

Appendix 3 b

No	Botanical name	Part of the plant used	Composition	Folk medicine use for
25	Securidaca longipedunculata	roots	-methyl salicylate saponins, tannins, glucoside	antihelmintic
26	Securinega virosa	leaves twigs	-	antischistosomiasis
27	Tagetes minuta	herbs	-essential oil carvon, linalol, terpene	-
28	Tarchonanthus camphoratus	leaves	-essential oil camphor tarchonylalcohol	headache, venereae diseases asthama, bronchitis
29	Ziziphus mucronata	roots	-	antischistosomiazis (bilharzioses)

Appendix 4

SOWING PLAN

VEGETABLES GARDEN

								1,o m
	Foeniculum officinale 18	Cynara scolymus 17	Lavandula angustifolia 19	Melissa officinalis 2o	Plantago lanceolata 21	Salvia officinalis 22	Saponaria officinalis 23	Thymus vulgaris 24	
								o,5 m
	Althaea rosea 16	Mentha crispa 15	Mentha piperita 14	Salvia solarea 13	Digitalis lanata 12	Carum carvi 11	Tagetes patula 1o	Sinapis alba 9	2o
								o,5 m
	Calendula officinalis 1	Coriandrum sativum 2	Datura innoxia 3	Hyoscyamus niger 4	Matricaria chamomilla 5	Ocimum basilicum 6	Papaver somniferum 7	Pimpinella anisum 8	
								1,o m

IRRIGATION PIPES AND EUCALYPTHUS TREE

SOWING: 15.XI.1982

Appendix 5

LIST OF MEDICINAL AND AROMATIC SPECIES RECOMMENDED TO BE INTRODUCED IN CULTURE

THE MAIN ELEMENTS OF CULTIVATION TECHNOLOGY

No	Botanical name	Period of vegetation	SOIL WORKS		SOWING			Main tenance works	HARVEST	
			Ploughing Depth(cm)	Before Sowing	Quantity (kg/ha)	Distance (cm)	Depth (cm)		Part of the plant	Manner of Harvesting
1	Calendula officinalis	Yearly	2o-25	Disk Harrow	6-7	5o	2-3	Hoed Weeded	Flower	Manual
2	Coriandrum sativum	Yearly	2o-25	Disk Harrow	2o	25	4-5	Weeded	When 5o-7o% of fruits are yellow	Manual or with combine
3	Datura innoxia	Yearly	28-3o	Disk Harrow	1o	5o	4-5	Hoed Weeded	Herbs when appears first fruit	Manual
4	Hyosoyamus niger	Yearly	2o-25	Disk Harrow	6	5o	1-2	Hoed Weeded	Leaves	Manual
5	Matricaria chamomilla	Yearly	15-2o	Disk Harrow Roller	4-5	25	o,o-o,3	Hoed Weeded	Flowers	Manual
6	Ocimum basilicum	Yearly	2o-25	Disk Harrow Roller	4-6	5o	1,5-2	Hoed Weeded	Herbs	Manual whit the sickle
7	Papaver somniferum	Yearly	2o-25	Disk Harrow Roller	2-3	5ox1o-15cm Between Plants	1-2	Hoed Weeded	Seeds and the Capsules	Manual
8	Pimpinella anisum	Yearly	2o-25	Disk Harrow Roller	1o	5o	2-3	Hoed Weeded	When 5o% of the fruits are Yellow	Manual whith the sickle

No	Botanical name	Period of vegetation	SOIL WORKS		SOWING			Main tenance works	HARVEST	
			Ploughing Depth(cm)	Before Sowing	Quantity (kg/ha)	Distance (cm)	Depth (cm)		Part of the plant	Manner of Harvesting
9	Sinapis alba	Yearly	2o-25	Disk Harrow	1o-12	25	2-3	Hoed Weeded	When the plants are Yellow	Manual or with combine
1o	Tagetes patula	Yearly	2o-25	Disk Harrow Roller	4-5 Manual	5o	1-1,5	Hoed Weeded	Flowers	Manual
11	Althea rosea var.nigra	Perennial	28-3o	Disk Harrow	6-8	75	2-3	Hoed Weeded	Flowers	Manual
12	Cynara scolymus	Perennial	28-3o	Disk Harrow	4-5	75	3-5	Hoed Weeded	Leaves	Manual
13	Foeniculum vulgare	Perennial	28-3o	Disk Harrow	8-1o	75	2-3	Hoed Weeded	When in the fruits are Yellow Brown	Manual or with combine
14.	Lavandula angustifolia	Perennial	28-3o	Disk Harrow	Nurseling	looxso	-	Hoed Weeded	Flowers with 1o-12 cm stem	Manual with sickle
15	Melissa officinalis	Perennial	28-3o	Disk Harrow Roller	8-1o	5o	o,5-1	Hoed Weeded	Herbs in Bloom	Manual with sickle
16	Plantago lanceolata	Perennial	2o-25	Disk Harrow Roller	5-6	5o	o,5-1	Hoed Weeded	Leaves	Manual with sickle
17	Salvia officinalis	Perennial	28-3o	Disk Harrow	6-8	75	3-4	Hoed Weeded	Leaves	Manual

Appendix 5 b

No	Botanical name	Period of vegetation	SOIL WORKS		SOWING			Main tenance works	HARVEST	
			Ploughing Depth(cm)	Before Sowing	Quantity (kg/ha)	Distance (cm)	Depth (cm)		Part of the plant	Manner of Harvesting
18	Saponaria officinalis	Perennial	28-3o	Disk Harrow	8-1o	5o	2-3	Hoed Harrow	Roots in the 2nd year	Manul with spade
19	Thymus vulgaris	Perennial	28-3o	Disk Harrow	Nurseling	5ox2o with 2-3 plants	-	Hoed Weeded	Herbs in Bloom	Manual with sickle
2o	Carum carvi	Two years	28-3o	Disk Harrow Roller	4-6	5o	1,5-2	Hoed Weeded	When 35-4o% of fruits are yellow	Manual with sickle
21	Digitalis lanata	Two years	2o-3o	Disk Harrow Roller	3-4	5o	1-1,5	Hoed Weeded	Leaves	Manual with knife
22	Salvia sclarea	Two years	28-3o	Disk Harrow	6-8	75	2-3	Hoed Weeded	Flowers	Manul with sickle
23	Mentha piperita	Yearly	28-3o	Disk Harrow	12oo Roots	75	8-1o	Hoed Weeded	Herbs in Bloom	Manul with sickle
24	Mentha crispa	Yearly	28-3o	Disk Harrow	12oo Roots	75	8-1o	Hoed Weeded	Herbs in Bloom	Manual with sickle

ATTENTION: TWO IRRIGATION PER DAY BY THE ROWS
OF EACH SPECIES MUST TAKE 2oo/5oo g GREEN MASS,
WHICH TO BE DRAYED AT THE SHADE

Appendix 6

THE OBBSERVATIONS IN THE VEGETATION PERIOD

No	Botanical name	Date		Part of the plant used	Period of the harvesting	Date of the harvesting	The weight of eample (g)	
		Sowing	Spring In bloom				Green	Grying
1.	Calendula officinalis	15.11	25.11	Flowers	Im bloom		3oo	
2.	Coriandrum sativum	15.11		fruits	when 5o-7o% of fruitss are yellow		2oo	
3:	Datura innoxia	15.11	25.11·	Herb	when appears first fruit		5oo	
4.	Hyoscyamus niger	15.11		Leaves	In bloom		4oo	
5.	Matricaria chamomilla	15.11		Flowers	In bloom		3oo	
6.	Ocimum basilicum	15.11	21.11	Herb	In bloom		5oo	
7.	Papaver somniferum	15.11		Seeds and capsules	When the capsules are dried		3oo	
8.	Pimpinella anisum	15.11		Fruits	when 5o% of the fruits are yellow		2oo	
9.	Sinapis alba	15.11	21.11	Seeds	when the plants are yellow		2oo	
1o.	Tagetes patula	15.11	21.11	Flowers	In bloom		4oo	
11.	Althaea rosea var.nigra	15.11	21.11	Flowers	In bloom		3oo	
12.	Cynara scolymus	15.11	25.11	Leaves	when the leaves are long 25-3oom		4oo	

Appendix 6 a

No	Botanical name	Date: Sowing	Date: Spring	Date: In bloom	Part of the plant used	Period of the hervesting	Date of the hervesting	The weight of sample (g): Green	The weight of sample (g): Drying
13.	Foenicum vulgare	15.11	25.11		Fruits	when fruits are yellow brown		2oo	
14.	Lavandula angustifolia	15.11			Flowers with 1o-12 cm stem	In bloom		3oo	
15.	Melissa officinalis	15.11			Herb	In bloom		5oo	
16.	Plantago lanceolata	15.11	21.11		Leaves	when the leaves are 2o-25 cm long		3oo	
17.	Salvia officinalis	15.11	21.11		Leaves	In bloom		3oo	
18.	Saponaria officinalis	15.11			Roots	In the end of 2nd year		4oo	
19.	Thymus vulgaris	15.11	21.11		Herb	In bloom		5oo	
2o.	Carum carvi	15.11			Fruits	when 35-40% of fruits are yellow		2oo	
21.	Digitalis lanata	15.11			Leaves	when the leaves are 2o-25 long		3oo	
22.	Salvia sclarea	15.11			Flowers	In bloom		5oo	
23.	Mentha piperita	15.11			Herb	In bloom		5oo	
24.	Mentha crispa	15.11			Herb	In bloom		5oo	

Appendix 7

LIST OF TEAS OF SOME MEDICINAL AND AROMATIC PLANTS CULTIVATED

No	Botanical name	Content	Therapeutical effect	Mode of preparing
1.	Calendula officinalis	saponosides carotinoides flavonoides	gastrites eczemes, burns cicatrizant	IN: 2 teaspoons flowers for 200 ml EX: 6-8 spoons flowers for 1 ltr.
2.	Matricaria chamomilla	essential oil (0,5-0,8%) azulenes, apigenin	antiseptic, cicatrizant, amigdalites, enterocolites	IN: 1-2 teaspoons flowers for 200 ml EX: 3 spoons flowers for 200 ml
3.	Pimpinella anisum	essential oil (2-3%), anethol (80-90%)	carminative, anticolics	IN: children: 6-8 fruits for 100 ml adults: 1/2 tsp fruits for 100 ml
4.	Althaea rosea var.nigra	mucilages, tanin colouring	antibronshitics	IN: 1 tsp.flowers for 200 ml
5.	Foenioulum vulgare	essential oil (2-5%), anethol (50-60%),limonen flavonoides	carminative, anticolica	IN: children: 5-7 fruits for 100 ml adults: 1/2 tsp fruits for 100 ml
6.	Melissa officinalis	essential oil (1,5-2%), citral geraniol, linalool, tanin	antivomitiv, cicatrizant	IN: 1 tsp.leaves for 200 ml EX: 2 spoons leaves for 200 ml
7.	Plantago lanceolata	mucilages, aucubin, tanin	pectoralm antihemoragic, hipertension	IN: 1 spoon leaves for 200 ml EX: 2 spoons leaves for 200 ml (gargle)

Appendix 7 a

No	Botanical name	Content	Therapeutical effect	Mode of prepring
8.	Salvia officinalis	essential oil (1,5-2,5%), salviol, comphor, tuion, pinen	antisudirific, sedativ	IN: 2 tsp leaves for 2oo ml
9.	Thymus vulgaris	essential oil (o,5-2%) sapomosides, cafeic acid	antihelmitic, antiasmatic, antispastic, antirheumatic	IN: 2 teaspoons leaves for 2oo ml EX: 8-12 spooms leaves for 2oo ml
1o.	Carum carvi	essential oil (2-4%), carvone, limonen	carminativ, anticolics	IN: Children: 8-1o fruits for 1oo ml adults: 1/2 teaspoons fruits for 1oo ml
11.	Mentha piperita	essential oil (2-3%), menthol (5o-6o%), flavonoides, polifenolis, tanin	antidiaretic, antivomitiv, antirheumatic	IN: 1 teaspoon leaves for 2oo ml EX: Friction with 5 ml essential oil in 1oo ml alcohol
12.	Cynara scolymus	cinarin, clorogenic, acid, polifenoles, flavonosides	aterosclerose, diskinezies, uremie	IN: 1 tsp. 1spoon leaves for 1 l in the end of 3 weeks period. To drink before breakfast, lunch etc After 3 weeks treatment=1-2 weeks break.

IN: used internally

EX: used externally

Every tea must be prepared in the indicate quantity hot water

Appendix 8

LIST WITH THE QUALITATIV CONTENT OF SOME MEDICINAL PLANTS OF BOTSWANA

No	Botanical name	Part of the plant used	Content	
1.	Colophosperum mopane	Fruits	- steroids	+
			- polyuranides	+
			- catechic tannins	++
			- anthocyanins	+-
			- flavones	+
2.	Cynara scolymus	Leaves	- polyphenols	+-
			- flavones	+++
			- bitter campounds	++
			- glycozides	+
			- mucilages	+
			- tannins	+
			- polysacharides	+
3.	Harpagophytum procumbens	Bulb	- catechic tannins	+-
			- polysacharides	+
			- mucilages	+
			- polyphenols	++
4.	Peltophorum africanum	Cortex	- steroids	++
			- cumarins	+
			- flavones	+
			- anthocyanins	+
			- mucilages	+
			- gallic tannins	+++
5.	Asclepias fruticoza (Gomphocarpus fruticoza)	Fruits with seeds	- catechic tannins	+
			- cardiotonic heterozides	+-

Appendix 8 a

No	Botanical name	Part of the plant used	Content	
6.	Pterocarpus angolensis	Cortex	- catechic tannins	++
			- anthocyans	+
			- steroids	++
			- flavonol	+
			- mucilages	++
7.	Plumbago zeylanica	Cortex	- steroids	+
			- essential oil	-+
			- polysaccharides	+-
8.	Solanum incanum	Fruits	- steroid glucoalcaloids	++
			- organic acids	+
			- polysaccharides	+
			- saponozides	+
			- anthocyanins	+
			- tannins	+
			- fatty oil	+
9.	Rhus pyroides	Leaves	- steroides	+
			- catechic tannins	+++
			- essential oil	++
			- antocyanins	+-
			- flavones	+
			- rezines	+-
10.	Rhus leptodictya	Leaves	- catechic tanins	+++
			- anthocyanins	+
			- flavonol	+-
			- essential oil	+-
			- rezines	+

Appendix 9

LIST WITH THE QUANTITATIVE CONTENT OF SOME MEDICINAL PLANTS OF BOTSWANA

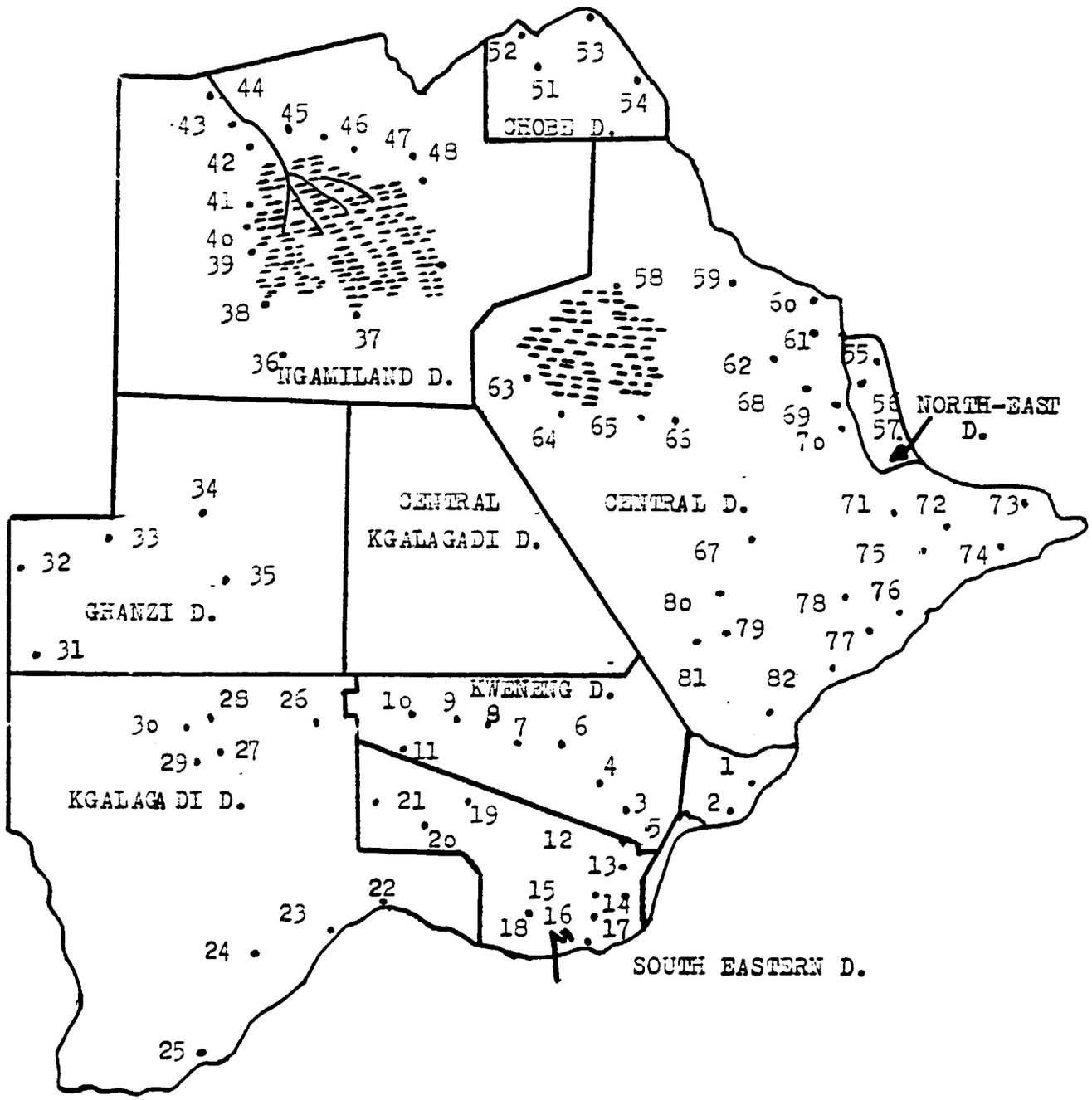
No	Botanical name	Date of the harvesting	Part of the plant used	Activ principles	Content g%
1.	Solanum incanum	october 82	fruits	solasodin	o,818
2.	Harpagophytum procumbens	october 82	bulbs	polyphenols (cynarin)	3,7o
3.	Cynara scolymus (cultivated)	october 82	leaves	flavones (luteolin)	1,75
				polyphenols (cynarin)	o,22
4.	Datura ferox	march 83	twigs	alcaloides (hiosciamin)	o,219
5.	Datura innoxia (cultivated with seeds from Romania)	march 83	twigs	alcaloides (scopolamin)	o,153
6.	Datura innoxia	march 83	twigs	alcaloides (scopolamin)	o,1o7
7.	Datura stramonium	march 83	twigs	alcaloides (hiosciamin)	o,286
8.	Solanum panduriforme	march 83	fruits	solasodin	o,797
9.	Solanum incanum	march 83	fruits	solasodin	o,831
1o.	Argemone mexicana	march 83	fruits (with seeds)	morphin	o,o8
11.	Ricinus communis	march 83	seeds	fat oil	37,5

Appendix 1o

LIST WITH THE QUANTITATIVE CONTENT OF SOME AROMATIC PLANTS OF BOTSWANA

No	Botanical name	Date of the harvesting	Part of the plant used	Essential oil ml%
1.	Artemisia afra	october 82	Leaves	1,33
2.	Croton gratissimum	october 82	Young twigs	1,07
3.	Cymbopogon plurinoides	october 82	Herbs	3,25
		march 83	Herbs	0,60
4.	Eucalyptus glabulus (cultivated)	october 82	Young twigs	2,48
5.	Helichrysum zeyheri	october 82	Herbs	0,23
6.	Lantana camara	october 82	Herbs	2,00
7.	Myrithamnus flobelli-folius	october 82	Young twigs	0,77
8.	Ocimum americanum	october 82	Herbs	0,92
9.	Ocimum canum	october 82	Herbs	1,11
		march 83	Herbs	0,92
1o.	Salvia species	october 82	Herbs	0,12
11.	Tarconanthus camphoratus	october 82	Herbs	0,54
12.	Lippia rehmanii	march 83	Twigs	2,5o
13.	Mentha longifolia (cultivated)	march 83	Herbs	1,61
14.	Rosmarinus officinalis (cultivated)	march 83	Twigs	1,00
15.	Tagetes minuta	march 83	Herbs	0,7o
16.	Thymus citriodora (cultivated)	march 83	Twigs	0,25
17.	Ocimum basilicum (cultivated with seeds from Romania)	march 83	Herbs	0,81

Appendix 11


CHOBE D.
NGAMILAND D.
NORTH-EAST D.
CENTRAL KGALAGADI D.
CENTRAL D.
GHANZI D.
KWENENG D.
KGALAGA DI D.
SOUTH EASTERN D.

Appendix 12

LIST OF LABORATORY EQUIPMENT FOR THE ABALYSIS OF THE MEDICINAL AND AROMATIC PLANTS

No	I T E M	Quantity
1.	Apparatus for determination of essential oil (Lighter than water and Haavier than water)	4
2.	Vacuum pump aseembly	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 (1o ml)	1o
9.	Burettes (25 ml)	1o
1o.	Laborm tory centrifuge	1
11.	Round bottom flask (1oo-25o ml)	25
12.	Analytical balance	1
13.	Drying stove	1

Total estimated cost including
1o% for transport .....US $ 1o.ooo

Appendix 13

LIST OF THE PILOT PLANT EQUIPMENT FOR EXTRACTION AND DISTILLATION OF MEDICINAL AND AROMATIC PLANTS

No	I T E M	Quantity
1	Extractor (percolator); Cap.3o-5o l material: Stainless steel	1
2	Extractor with mechanical stirrer (agitator) at atmospheric pressure; Cap.1oo l material: Stainless steel	1
3	Manual Filter Press; Cap.3o kg	1
4	Concentrator for extracts with vacuum pump and refrigerator; Cap.2o l; Electrical heating material: Stainless steel	1
5	Distilator for essential oils with refrigerator florentin vessel and wooden (electrical) heating; Cap.25o l, material: Stainless steel	1
6	Receiver and sedimentation vessel for extraction solutions; Cap.5o l material: Stainless steel	1
7	Balance 5-1oo kg	1
8	Pipes, Fittings and Taps	-

Total estimated cost including

1o% for transport .....US $ 5o.ooo

Appendix 14

L I S T

OF PERSONS MET BY UNIDO EXPERT

1. Mr.Manzur Zaidi - UNDP - Resident Representative
2. Mr.H.M'Cleod - UNDP - D.R.R.
3. Mrs.Renate von Hovel - UNDP - JPO.
4. Mr.K.B.Bareki - Permanent Secretary - Ministry of Commerce and Industry
5. Mrs.D.T.Tibone - Principal Industrial Officier (M.C.I.)
6. Mr.Klaus Eder - Senior Industrial Officier (M.C.I.)
7. Mr.Dr.T.S.Moeti - Ministry of Health
8. Mr.Kwerepe - Rengy Ecologist, Ministry of Agriculture
9. Mr.Dr.K.Uland Director of the Departament Agricultural Research - Sebele
10. Miss Pearl Motsepe - Botswana Agriculture College
11. Mr.Dr.Tabe Tiatemo - Ecologist, National Institut for Research
12. Mr.Frank Taylor - Director "Veld Products Research" Gabane
13. Miss Helen Moss - Botanist "Veld Products Research" Gabane
14. Mr.Mpha Mmopi - Botswana Develop.Corporation
15. Mr.S.Ketlogetswe - Director Import, Export and General Agents
16. Mr.Derek Medford - Director Botswana Technology Centre
17. Miss Dr.Christine Sydes - Biology Departament, University of Botswana

Appendix 14 a

18. Mr.Alec Campbell - Director of the National Museum
19. Miss Manana Lefhoko - Central Medical Stores
20. Mrs.Annah Badumetse - Gaborone Nursery
21. Mr.S.R.Day - Gaborone Town Council Nursery - Parks

Appendix 15

LIST OF RECOMMENDED REFERENCE BOOKS

1. THE MEDICINAL AND POISONOUS PLANTS OF SOUTHERN AND EASTERN AFRICA
   By J.M.Watt and M.G.Breyer - Brandwiyk
   E.and S.Livingstone Ltd.
   Edinburgh and London, 1962
2. TREES OF SOUTHERN AFRICA
   By K.C.Palgrave and R.B.Drummond
   C.Struik Publishers
   Cape Town -Johanesburg, 1977
3. HANDBOOK OF BOTSWANA ACACIAS
   By J.Timberlake
   Ministry of Agriculture, Botswana, 1980
4. A VEGETATIVE KEY TO THE WOODY PLANTS OF SOUTH EASTERN BOTSWANA
   By B.J.Woodllard
   University College of Botswana
5. RANGE MANAGEMENT HANDBOOK FOR BOTSWANA
   By L.Hendzel
   Ministry of Agriculture, Botswana , 1981
6. A HANDBOOK OF COMMON GRASSES IN BOTSWANA
   By D.I.Field
   Ministry of Agriculture, Botswana, 1976
7. A HANDBOOK OF BASIC ECOLOGY FOR RANGE MANAGEMENT IN BOTSWANA
   By D.I.Field
   Ministry of Agriculture, Botswana, 1978
8. POISONOUS PLANTS OF SOUTHERN AFRICA
   By J.Vahrmeijer
   Tafelberg, 1982
9. PLANTS POISONOUS TO LIVESTOCK IN BOTSWANA
   By Pearl D.Motsepe
   Gaborone, 1982

Appendix 15 a

1o. FINAL REPORT ON THE POTENTIAL FOR COMMERCIAL UTILIZATION OF VELD PRODUCTS (Volume I)

The resource and its management

By P.W.Taylor with H.Moss