OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

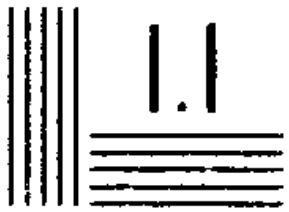
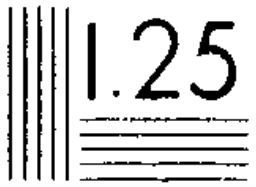
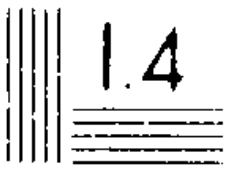
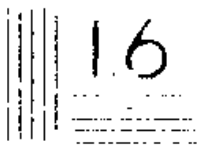
FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org


1.0

1.1

1.25

1.4

1.6

RESTRICTED

DP/ID/SER.B/467
17 July 1984
ENGLISH

13888

UTILIZATION OF AROMATIC PLANT NATURAL RESOURCES
IN THE PRODUCTION OF PHARMACEUTICALS

SI URT 82 803

ZANZIBAR

Terminal report *

Prepared for the Government of Zanzibar
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of B.C.Gulati,
Pharmaceutical Adviser - Expert in Essential Oils

United Nations Industrial Development Organization
Vienna

* This document has been reproduced without formal editing.

V.84-88450

I N D E X

Contents

PART TWO : Annexures

XXII List of Indian standards on Natural and Synthetic Perfumery Materials

XXIII British Standards on some important Essential Oils

XXIV ISO Standards on Essential Oils prepared by ISO/TC 54.

XXV B.P. specifications on Essential Oils

XXVI Specification on spices and some spice oils

XXVII Important aspects of Analysis of Essential Oils

XXVIII Design of condenser for camphor-rich materials

XXIX Flow Sheet Diagram:Eugenol from Clove leaf oil

XXX Design of Laboratory Distillation unit

XXXI Design of Distillation unit - 200 kg capacity

XXXII Design of water-steam distillation unit -300 kg capacity

XXXIII Traditional medicines and role of traditional medicine practitioner in Zanzibar and Pemba

PART THREE : PROJECT PROPOSAL

Part A - BASIC DATA

Part II - NARRATIVE

1. Background and Justification

2. Special Considerations

3. Objectives

4. Project Output

5. Project Activities

6. Inputs

7. Envisaged Follow-up

8. PART III Project Budget

P A R T O N E

M A I N R E P O R T

I. INTRODUCTION

The United Nations Industrial Development Organisation initiated an exploratory study of the medicinal and aromatic natural flora of Tanzania through a mobile unit under the auspices of the Joint UNIDO - Roumania Centre with a view to identifying plants for use in the Pharmaceutical Industry. The preliminary study under the Project (RP/RAF/79/005) indicated possibility of utilization of a few aromatic and medicinal plants occurring both in state of nature and under cultivation. On the basis of this preliminary data and the desire of the Government concerned, a project proposal was formulated to undertake a further study of the plants, especially, essential oil-bearing for their utilisation in the pharmaceuticals.

1.1 Objective of the Project

Main objectives of the project were as under:-

i) To assess the present facilities for the production of essential oils in Zanzibar from aromatic plants already growing in the island; and to evaluate the prospects of indigenous utilisation of these oils in the production of pharmaceuticals both for local use as also for export.

ii) To prepare a Technical Report including assessment of the possibility of producing essential oils in Zanzibar and their utilisation in the pharmaceutical production.

iii) To indicate suitable technologies for use in local situation, the equipment inputs, analytical methods and quality standards for the essential oils and means of ensuring the maintenance of quality.

iv) To recommend training requirement for personnel in order to make the industry viable and ensure its satisfactory operation.

v) And, lastly, to submit a Draft Project Proposal for follow up action.

2. Conduct of the Mission

The project URT/82/803 was undertaken with effect from 5 October 1983 in the Phamaceutical Plant of the Ministry of Health, Government of Zanzibar. Prior to the arrival of the Expert, a tentative programme of work was chalked out by the concerned officials in Zanzibar, laying stress on the role of and information on the use of local plants by the Traditional Village Practitioners. (Annexure I). However, at the instance of the Expert, the programme was revised; besides the above to an extent, which would yield further information on botn the essential oil-bearing and medicinal plants, the emphasis was laid more on the evaluation of their economic utilisation and eventually production of items, first in the laboratory and later on pilot scale. The products so obtained would be analysed for their physico-chemical characteristics and content of active ingredient (s); and comparison made with the established Standards/Pharmacopoial requirements.

It was also suggested that the Expert, while studying the overall availability and potential of essential oil-bearing plants of the island, may indicate other economic plants that would be used in the pharmaceutical industry. This was studied side by side without affecting the main objectives of the project.

2.1 The project was started on following lines :

2.1.1 Study of available literature and information on the flora of Zan ibar and Pemba with special reference to essential oil - bearing, medicinal and related plants that could be useful. Discussions were held with various specialists on the plants and their availability for work in the laboratory.

2.1.2 Organisation of laboratory work in the pharmaceutical plant for evaluation and study of the plants. A small distillation unit of about

75 litres capacity was designed to run on elecricity for distillation of material in quantities sufficient for ehemical evaluation.

2.1.3 Analysis of the essential oils for their physico-chemical characteristics and estimation of active ingredients.

2.1.4 D scussions with local traditional medicine practitioners in Zanzibar and Pemba to get information on various plants used in folk medicine. (Annexures XXXIII)

2.2 Study of Avalable Literature

It was considered important to have not only exhaustive but also correct information on the essential oil-bearing and medicinal plants found both in state of nature and under cultivation. List of these plants so prepared, along with local and botanical names and their uses is given in Annexures II and III.

While compiling the list as referred to above, plants considered potential sources of covering insecticides, dentifrice, starch and fixed oils are given separately vide Annexure IV.

The list of plants, so preparèd, was discussed further with the officers of the Ministry of Agriculture, Forestry, Zanzibar State Trading Corporation (ZSTC) besides the Plant Manager of the Pharmaceutical Plant, Ministry of Health, in order to narrow down the choice of plants for work during the short stay of the Expert.

2.3 Setting up of Laboratory Facilities

The Phamaceutical Plant has a laboratory equipped with various items of equipment, apparatus and chemicals. This laboratory, however, lacked facilities for work on essential oil-bearing plants and essential oils.

Organising the laboratory facilities took a great deal of time and effort as various items of glass ware and chemicals had to be arranged from other organisations. A simple all-glass distillation apparatus was

assembled. However, for distillation of larger quantities of material to get sufficient produce for analysis, a unit of 75-litre capacity, made of galvanised iron sheet was designed and fabricated locally in the Small Scale Industries Department. The unit was fitted with false bottom, a 2 kw heater and a detachable condenser for ease in operation. Annexure XIX.

Also, for analysis of essential oils for the physico-chemical properties only a few items of glassware and chemicals could be arranged. List of apparatus, equipment and chemicals for regular laboratory work on essential oil-bearing plants and their products is included in this report, vide Annexure V.

2.4 Evaluation of Essential Oil-bearing plants in the Laboratory

Of the essential oil-bearing plants, available in the area, work was done on the following plants, both on small scale in the glass distillation assembly (capacity 1000 ml) and on pilot scale in the metal distillation unit (capacity 75 litres). Local and established uses of these plants and their products are summarised hereunder for ready reference:

Plants	Uses
1. Ocimum species	
a) Ocimum basilicum (?)	Seemed to be new unworked species/variety. Plant is used as hair application. In Tanzania leaf is used for bilharzia and as snake bite remedy. In Brazil, plant is used as diuretic and diaphoretic.
b) Ocimum americanum	Out of various chemical types, camphor type could be useful in the pharmaceuticals in Zanzibar.
c) O. sauve	Leaf used to perfume chewing tobacco and snuff. Smoke from burning plant is mosquito repellant. Oil is used as a stomachic and as an "anthelmintic".
d) Ocimum basilcium (Methyl cinnamate type)	Seemed rich in methyl cinnamate (can have export potential).

2. Lippia asperifolia	Plant has many medicinal uses in the area. (Oil of verbena ex. Lippia citriodora is an established essential oil in the industry).
3. Pimenta officinalis (All spice)	Oil used as carminative and flavouring agent. Full grown unripe berries are aromatic carminative but generally only oil is used.
4. Cinnamomum zeylanicum	Bark oil is carminative and astringent. Used as flavouring agent; occasionally as an inhalation, also used as a spray. Oil has preservative properties.
5. Elettaria cardamomum var. minuscula (True Cardamom).	Fruit has carminative properties; is often given with purgatives and with other aromatics. Oil is used as carminative and flavouring agent.
6. Cymbopogon citratus (Lemon grass - West Indian)	Now mainly used as a starting material for Vitamin A and perfumery chemicals, is used as perfume base for detergents. It is one of the most important essential oils used in industry in the world.
7. Myristica fragrans (Nutmeg)	Oil is carminative and flavouring agent. It is mildly rubefacient and has been used in liniments and hair lotions.
8. Coriandrum sativum	Fruit is aromatic and carminative, added to purgative medicine to prevent griping. Oil is aromatic, stimulant and carminative.
9. Vanilla planifolia	It is flavouring agent and used in perfumery. (Vanillin, the main constituent of vanilla is an ingredient of calcium gluconate tablets, liquid paraffin emulsions and methyl cellulose granules).
10. Vetiveria zizanioides (vetiver)	Oil used as perfumery and flavouring agent. Resin in the root used as abortifacient; root as aromatic tea.
11. Eucalyptus species	
i) E. saligna	Contains some oil. Composition need to be studied further.
ii) E. zanzibarica	Not studied so far. (In Zanzibar, many species are reported to occur. For want of proper authentication, more species were not studied).

12. Eugenia caryphyllus — Studies were undertaken in details on leaf oil only. The oil has varied uses in pharmaceutical, flavouring and perfumery industry. Clove leaf oil is one of the most important essential oils in the industry.

As the essential oil-bearing plants are harvested for distillation during a particular stage of vegetative growth, it acted as a constraint for working on some of the plants which were not ready for harvesting during October to March, i.e. during the stay of the Expert.

After discussion with the officers of the Ministry of Agriculture, a request was made in writing on 26 December 1983 indicating requirement of various plant materials for work. (Annexure VI). Most of the items were not supplied till March end 1984.

Results and findings of laboratory work are summarised under Laboratory Investigations (Chapter 7).

3. Zanzibar and Pemba Islands : A brief description

Zanzibar and Pemba Islands are situated off the coast of East Africa in the Indian Ocean. They form a part of United Republic of Tanzania (previously known as Tanganyika) but having own administrative, financial and ministerial set up. Zanzibar island is about 65 km long and 25 km broad situated at a distance of 40 km from Tanzania mainland. Pemba, 50 km from Zanzibar is about 55 km long and 15 km broad with different terrain and topography than Zanzibar. Both the islands are inhabited by about 500,000 people.

Zanzibar and Pemba receive an average of 150 cm and 200 cm of rainfall per annum respectively which is just sufficient to support their main crop, namely cloves. Zanzibar has 102 days of rain while Pemba has 162 days of rain.

The seasons of the year are typical and clearly marked. The year begins with warm winds from the North East and two months of dry but not unpleasant weather, known as Kaskazi period. At the end of February or

beginning of March the North East winds begin to die down followed by a short period of heat unrelieved by wind. This lasts till about the third or fourth week of March, whereafter, the early heavy showers of the Masika or great rains occur. April and May are wet months. June brings cool winds from the south west and rains usually cease. Again, during August and September light showers are received, known as Mchoo, Kipupwe, Mvua za Mbaazi, etc. Cool weather continues throughout September and early October during which period South West Monsoon begin to taper off and by November the Vuli or light rains arrive making it a wet month. By middle of December, the North East wind starts blowing again, the hot dry weather of Kaskazi brings the year to an end.

Economy of Zanzibar is primarily agriculture; cloves and to some extent coconut being the major plantation crops while the minor ones being cashewnut, pineapple, chillies, citrus fruits, coffee, derris, durian, mango, tobacco, avocado, sugarcane and cacoa. Cassava, rice, maize and sweet potatoes are the major food crops.

There are a number of essential oil-bearing plants (including spices and condiments for the purpose of this Report) which are cultivated as also occur in the state of nature.

The islands hold promise of introducing many other species of economic importance which are discussed in the Report.

4. Production Facilities for Essential Oils in Zanzibar & Pemba

Distillation facilities and capacity both in Zanzibar and Pemba according to the Expert are far in excess of the availability of the raw materials, i.e. essential oil-bearing crops. Distillation units were set up in Zanzibar in 1930 while the same have been installed in Pemba only recently in 1982. Both the centres are established primarily for processing of clove stems obtained as a bye-product of clove production.

Distillation Centre at Zanzibar is under the Zanzibar State Trading Corporation for all its operations right from purchase of clove stems to marketing the oil. The unit at Pemba is now under the Ministry of Industry and is being run as an independent company responsible for production and marketing policies. Details on these units are as under:

4.1 Zanzibar State Trading Corporation Distillation Centre, Zanzibar

The distillation centre is located in Malindi, in Zanzibar town under ZSTC. The distillation assembly built by John Dore & Co. London, comprises of 12 units, made of copper, housed in one hall in 2 parallel assemblies of 6 each, with 6 tubular condensers, one each for two units. Every unit has its own florentine flask, made of aluminium. The stills are properly lagged to conserve heat.

Each unit take a charge of 750 kg dry clove stems. Distillation unit is divided into two chambers. Stems are charged manually and packed tightly by stamping over with manual labour. Steam is injected from the bottom through a steam coil. It takes in all 18 hours to complete one distillation, 2 hours are used for charging the stems.

Steam is generated in a boiler housed in an adjoining building using coconut husk and dry exhausted clove stems after distillation as fuel.

Oil is removed at regular intervals of one hour from the florentine receiver through the opening at the bottom (oil being heavier than water) and stored in a settling tank for a week before packing in the drums. Sludge which settles down at the bottom of tank is centrifuged in Sharpnel centrifuge to recover oil.

During the course of distillation, while bulk of oil which

distills over settles as a heavy oil, a small intermediate phase containing oil separates between upper water phase and lower oil phase. This layer which is black in colour is removed separately, oil recovered and mixed with the main oil to form complete oil.

Distillation is carried out at a steam pressure of 5 to 10 PSI in the unit, while steam pressure in the boiler is maintained at about 80 PSI. Water coming out from the florentine receiver is fed back to the distillation unit, i.e. cohobation is practised for recovery of full oil.

Exhausted stems after distillation are removed manually from the unit through a side man-hole, dried in the open and used as fuel.

Yield of oil per charge varies from 35 kg to 40 kg i.e. oil recovery is 4.7 to 5.3 per cent. Average oil yield comes to 5 per cent.

Individual drums are analysed for eugenol content by a chemist of the Government Laboratory before shipment. Zanzibar clove oil conforms to the standards as laid down by British, American and International Standards Organisation.

The units, when operating at full capacity are manned by 2 supervisors, 3 boilermen and about 24 labourers for charging, discharging and miscellaneous operations. One charge is completed in 2 shifts. The staff is well versed in the distillation procedure producing oil of standard quality.

Overall maximum capacity of the ZSTC distillation centre at Malindi is 900 kg of clove stems per day in 2 shifts. Under optimum condition of working and with regular supply of clove stems, about 2700 tons of clove stems corresponding to 130 tonnes of oil can be distilled per annum. However, under normal conditions, it can easily distil about 2000 tonnes of clove stems producing about 100 tonnes of oil per annum.

Present Situation - The units which were installed in 1930 underwent major repairs recently and practically no oil was produced during the last 3 years. The units were repaired by December 1982 but for want of regular supply of clove stems in Zanzibar, they are working at a fraction of their capacity. Also, stems which were earlier available from Pemba, the major producer of cloves, are now used there by the distillation centre in Pemba. As a result, this centre is left with a large surplus capacity.

4.2 Distillation Units at Pemba (Chake Chake)

A new modern distillation centre has been set up in Pemba with French equipment (La Tournaire Frere SA) and know-how. Distillation trials were made during September 1982; regular distillation was started from December 1983 but was stopped again for want of raw material, i.e. clove stems. The plant was formally inaugurated on 12 January 1984 by Mr. J.K. Nyerere, President, United Republic of Tanzania.

Distillation units and all other contact parts are of stainless steel. Ten units of charge capacity of 700 kg of stems each (28 bags of 25 kg each) are housed in a separate building in 2 parallel rows. Each unit has separate condenser, florentine receiver and oil storage vessel of 40 kg capacity. Distillation unit is divided into 8 compartments by 7 perforated trays. Loading is done separately, a dummy distillation unit shell is embedded on the floor, the inner shell having perforated trays is packed with the stems, hoisted by a chain pulley block and inserted in the distillation unit. Lid is closed and steam is injected into the unit. Charging process is easy and takes little time.

After half an hour of the steam inlet, distillation starts and in 4 hours the distillation is completed. The spent material is removed along with the trays by hoist and taken to another room and discharged.

It is then dried in a drier, and fed into the boiler by a conveyer belt. The entire operation is smooth and clean.

Distillation is done under a steam pressure of 35 PSI in the unit; steam pressure in the boiler is kept at 150-160 PSI (Boiler supplied by M/s Dupex S.A.).

During the process of distillation, oil collected in the florentine receiver is removed at regular intervals and kept in a drum of 40 kg capacity. The exhausted distillate, which forms the upper phase in the receiver is stored in a separate tank (one tank per 5 units) where a periodical check is made to ensure that oil does not pass over with water. Any oil which passes over separates in this tank, and is removed.

Oil collected from each distillation unit is filtered through a sieve into a tank of 1000 litre capacity. After a day or so this oil is treated under vacuum (0.6 to 0.8 bars) to remove moisture. Moisture-free clear oil is pumped into a storage tank of 3,000 litre capacity. Oil is filled into 205-litre drums, weighed and sealed.

During the process of distillation, while bulk of the oil settles down in the receiver, a small intermediate phase, black in colour, separates in between water and oil layer. This is removed and treated for oil recovery. The colour remains black. It is mixed with the main oil to make a complete oil (black coloured oil constitutes only 0.04 per cent of the stems).

Oil recovery has been found to be 5.70 per cent (average) which is higher than that obtained in the ZSTC distillery in Zanzibar.

The phenol content (calculated as Eugenol) comes to 90 to 91 per cent. Analysis of bulk oil and 'black' oil is as under:

	Bulk oil	Black oil (Average of 4 analysis)
Colour	Pale Yellow	Black
Density ($20^{\circ}C$)	1.047	1.050
Refractive Index ($20^{\circ}C$)	1.534	1.535
Phenol content % (V/V)	90	84
Optical Rotation	0	0

Black coloured oil is termed as 'light' oil even though its density is nearly the same as that of 'heavy oil' (bulk oil). During the visit of the Expert, oil was checked for iron content which could be responsible for the colour. It was found that the colour is not due to the presence of iron, but to the pigment of stems which comes over during the later stages of distillation and is trapped by the oil in the water phase (TPI Report).

It is interesting to note that while phenol content in the black oil was found to be 84 per cent in Pemba, the same was found to be only 44.5 per cent by GLC in the TPI Laboratory, London. Another major constituent identified at TPI was caryophyllene (45.9%) which is present to the extent of 9.5 per cent in normal bulk oil.

While working at full capacity (22,500 kg of stems per day in 3 shifts) the distillary can distill annually 6750 tonnes of clove stems for 300 working days or 4,500 tonnes for 200 working days, corresponding to oil production of about 350 tonnes and 225 tonnes respectively.

It will be observed that combined capacity of both ZSTC unit at Zanzibar and Pemba Distillery comes to about 9000 tonnes of stems at optimum level and 6500 tonnes at normal working of 200 days. As one kg of dry stems are normally obtained from 5 kg of dry cloves,

the availability of stems at the level of 6500 tonnes per annum would correspond to a production of 32,500 tonnes of cloves which according to the Expert seems an impossible figure to achieve. Normal production of cloves in both Zanzibar and Pemba comes to about 8000 tonnes or a maximum of 12,000 in years of bumper crop. This indicates availability of 1,600 to 2,500 tonnes of clove stems, if all the stems are procured . Under these circumstances, the two centres can work at about 25 to 30 per cent of the installed capacity. There is, therefore, ample scope of using these units for production of other essential oils, with minor modification of florentine receivers to separate oils lighter than water.

There are two laboratories where some work on evaluation of essential oils can be done. These are described in Annexure VII and VIII.

5. Availability of Essential Oil Bearing and Medicinal Plants:

Zanzibar and Pemba of the United Republic of Tanzania are popularly known as "Spice Islands". While a number of spice plants have been introduced during the past, only cloves (ex. Eugenia caryophyllus (Sprengl.) Bullock et Harrison. syn. E. caryophyllata. Thunb. - Family Myrtaceae) acquired any commercial significance both in terms of economy and world trade. Zanzibar chillies, which were well known in the world trade, are no longer an item of export now. Overall export earnings of the islands are dependent almost entirely on cloves; which together with coconut account for about 90 per cent of the export earnings. Owing to decline in the production of cloves in Zanzibar in the recent past, Malagassy has now acquired an important position in the clove and clove stem oil in the world trade.

An idea about the availability of cloves and other spice and essential oil-bearing plants in Zanzibar is given hereunder:

5.1 Cloves

Clove is extensively cultivated in both Zanzibar and Pemba; 80

per cent of total estimated area of 32,000 ha. under cloves is in Pemba. Cultivation in Zanzibar has declined primarily due to disease, weather damage and replacement of clove cultivation with other cash crops, e.g. coconut, citrus, durian and rhambatan.

Cultivation of clove is done both by the Government farms and small farmers, the latter have more area and produce on the island of Pemba where about 50 per cent of the farmers are dependent on cloves only. Small farm holding average about one hectare. (By a Government regulation, felling of a live clove tree is prohibited in Pemba which acts as deterrant to crops diversification and replacement). On the other hand, about 35 per cent area on Government lands in reported to be devoted to clove plantation.

Production - At the age of 4 to 5 years, clove trees start bearing and yield a small crop; full bearing is, however, achieved at the age of 20 years which continues for another 50 years or so unless affected by disease.

Prior to 1946, large estates provided the bulk of the crop which was subsequently taken over by Government farms or distributed among small farmers. Harvesting and production of cloves is a tedious affair, done entirely manually. In earlier times, about half of the farmers would sell the standing crop to merchants who would in turn arrange and engage labour for this work. However, with the setting up of purchase centres by the ZSTC in Pemba and Zanzibar, more and more farmers have started harvesting and production of cloves on their own. At the present about 30 per cent of the farmers sell their crop to the merchants for the production of cloves.

Preparation of the spice involves removal of stems and sun drying, a labour intensive operation. In the days of large estates drying was often carried out on specially constructed concrete floors. Small

farmers, now, employ woven mats (imported) spread on any firm surface, even the roads, for sun-drying of the crop (using such unhygenic conditions for drying have their own drawback, primarily the risk of microbiological contamination which could pose problems of export to western countries where health and cleanliness regulations are becoming increasingly stringent).

Prefunctory grading is done by the farmer/merchant prior to sale to the ZSTC purchasing centre. In the ZSTC centre, the bags are opened and inspected by a Government Official of the Ministry of Agriculture. A subjective and visual assessment of the cloves is made by the Produce Section before assigning the Grade (Specifications of Clove Grades are given in Annoxuve-IX). Bulk of the clove produce falls into Grade II, the so-called "Zanzibar Standard Grade". After inspection, cloves are transported to the ZSTC godown in Malindi, Zanzibar.

Export — ZSTC handles the export trade. Cloves are kept in bags till export orders are received. Bags are opened, subjectively selected and mixed to make 'Zanzibar Standard Grade'. Ministry of Agriculture, Produce Section, issues the certificate for export. Cloves are packed in gunny or sisal bags of 50 kg net weight. Fumigation of cloves prior to export is not undertaken. Export of cloves is by sea; large quantities from Zanzibar port while small quantities from Dar es Salaam.

Consumption of cloves in the home country is negligible ; exports, therefore, give a fairly good idea about production. Average annual export during the quinquennium 1967-1971 was 10,114 tonnes (range 4,769 to 17,710 tonnes), 1972-1976 and 8,195 tonnes (range 3,665 to 11,758 tonnes), and was 5,552 tonnes during 1977-78 to 1981-82 (range 467 to 9,606 tonnes). It will be seen that the average annual export (5 years) has fallen from a high of 10,114 tonnes to a low of 5,552 tonnes

(practically by 50 per cent). Peak production of 19,000 tonnes was achieved in 1950-1951. In general, production and export have no set pattern; the fluctuations are beyond comprehension. Decline in production has many reasons which is beyond the purview of this Project.

Production potential in Pemba alone is 16,000 tonnes during bumper years of harvest and 12,000 tonnes in other years.

5.2 Cardamom

The true cardamom, Eletteria cardamomum (Linne) Maton (Family Zingiberaceae) was introduced from India for intercropping in the clove plantations. The programme was initiated by the Ministry of Agriculture in 1977. Both the Mysore and Malabar varieties are being grown. An area of about 80 ha has been established under nursery both in Zanzibar and Pemba. Only Malabar variety is doing well. About 100 ha area is already under cultivation, and a large number of seedlings (200,000-300,000) are reported to be distributed free. The main difficulty in successful cultivation of cardamom is in drying of the crop which coincides with the rainy season. An electric dryer is proposed to be installed and order has been placed with the Federal Republic of Germany.

Pemba has a better potential for cardamom cultivation than Zanzibar. There is no proposal at present for producing cardamom oil. However, it is yet to be ascertained whether Zanzibar-Pemba cardamoms would yield a good quality oil. Oil content was, however, found to be satisfactory by the Expert.

5.3 Lime Oil

Citrus aurantifolium Swingle (Fam: Rutaceae) is grown in Zanzibar. Previously the fruits were supplied to ZSTC which processed these into fruit (lime) juice and distilled (juice) oil. Production of the oil was to the extent of 500 kg per annum, average about 250 kg). Juice

was exported but is now used in the home market.

Sale of fruits to ZSTC has decreased lately as these fetch better price when sold as fresh in the market. There is also difficulty in exporting raw juice unless it is concentrated. This would need further investment which in the face of shortage of raw material (fruits) and finances is not advisable unless cultivation is increased.

5.4 Others

A number of other essential oil-bearing plants occur, both in state of nature as also are under development stage, such as lemongrass, vetiver, ocimum species and varieties, camphor tree, cinnamon, eucalyptus ylong ylong . pandanus etc. Efforts a re also being made to develop cultivation of true vanilla, nutmeg and pimento.

There is also possibilities of producing products from flowers which could be a new area of R & D. Further details are also given elsewhere in this Report.

Besides the above, Zanzibar has potential of producing products like castor oil, neem (margosa) oil and various products.

Essential oil-bearing, medicinal and other plants accurring in Zanzibar and Pemba are given in Annexures II, III, IV.

An idea about the essential oils produced and consumed in the world in flavour, fragrance and pharmaceutical industries is given in Annexure X.

6. Assessment of the Possibilities of Producing Essential Oils

Zanzibar and now Pemba Islands have adequate production/distillation facilities by way of equipment which is presently being used only for the distillation of clove stems for the oil. Combined capacity for both Zanzibar and Pemba, if operated realistically at fullcapacity, would come to 6,500 tonnes of stems yield about 325 tonnes of oil per annum. Achievement of this much production of clove oil is considered doubtful by the Expert; 6,500 tonnes of stems would become

available if clove production touches 32,500 tonnes and further if all the stems produced become available for distillation. Prospects of both these are doubtful. On an average, if all the available stems are procured at the present, the quantity would be at best 2000 tonnes. Quantity of stems available during bumper year of clove production would be marginally higher. Under these circumstances, both the distillation centres can work at about 30 per cent of the installed capacity; in other words, the surplus capacity of these units can be utilized if other materials for distillation are made available.

The main snag visualised in using these units is the acute problem of transport of the materials which would be available from wild growing or cultivated plant species at distant places.

6.1 Possibilities of Producing Essential Oils

While considering the possibilities of producing essential oils in Zanzibar and Pemba, the two islands are dealt with separately primarily due to their diverse topography. While Zanzibar can offer flat and plain areas, Pemba being hilly cannot be considered seriously for large scale cultivation of aromatic plants; whatever plain area is available can be best utilised for food crops. Irrigated area would also not be available easily and that too in large tracts in Pemba.

6.2 Zanzibar

Zanzibar island offers choice of producing essential oils from:

i) Material available at the present

ii) Material which could be available from cultivation in future

Material available at the present - Of the plants occurring in Zanzibar, the followings can be considered for distillation:

i) Cananga odorata var. macrophylla

ii) Cinnamomum camphora

iii) Cinnamomum zeylanicum

iv) Citrus species for both rind and leaf oil.

v) Cymbopogon citratus

vi) Eletteria cardamomum var. minuscula

vii) Eucalyptus species

viii) Eugenia caryophyllata (for leaf oil)

ix) Melaleuca leucodendron (cajeput oil)

x) Myristica fragrans

xi) Pimenta recemosa

xii) Pandanus spp.

xiii) Vetiveria zizaniodes

Production of essential oils for these plants on a reasonably large scale has to be considered from two aspects.

i) Domestic utilization

ii) Export possibilities

Domestic utilization of essential oils is possible only if there is a flavour and fragrance industry. There is none at the moment. The only item that can be considered for local consumption is lemon grass oil for detergent industry. However, the following items can possibly find outlet in the pharmaceutical industry.

i) Oil of cardamom or tincture of cardamom, both would need the cardamom fruit.

ii) Cinnamomum camphora, for camphor

iii) Cinnamom bark oil

iv) Eucalyptus species - if oil is rich in 1:8 cineol

v) Clove leaf oil for eugenol or rectified oil

vi) Pimento leaf and berry oil

Out of the above, material is available for distillation of

cardamom and clove leaf. For others, some work will have to be done such as in case of eucalyptus, and to get data on the availability of the material.

6.2.1 Material from cultivation in future

Government of Zanzibar has a plan for soil conservation. Choice of plants to be used for soil conservation is under active consideration. This aspect was discussed by the Expert with the Advisor to the Ministery of Agriculture. The following species of essential oil-bearing plants were suggested for this purpose:

i) Cymbopogon winterianus
(Citronella - Java type)

ii) Cymbopogon flexuosus
(Cochin or East Indian Lemon grass)

iii) Vetiveria zizaniodes (vetiver)

(A small note on the above species as also a few more relevant to Zanzibar and their essential oils covering world market and general aspects are appended with this Report vide Annexures XI to XVIII).

Citronella and lemon grass offer a good choice as agroclimatic conditions are favourable for their growth. Also, these species have a life span of about 5 years and will act as a good soil binder if planted in proper manner, i.e. crosswise and not in lines along with the flow of water. Planting material of the above, i.e. rooted slips for citronella and seeds of lemongrass can be procured from India. Citronella planting material will also be available from Guatemala, China and Indonesia.

Vetiver planting material can be had from India, Re-union Islands, China, Haiti and Indonesia.

Cultivation of these three species will help not only in utilising of surplus capacity of distillation units in Zanzibar but

will also help in export earnings and thus improving economy of the island.

Citronella oil can be used for making anti-mosquito cream, and lemongrass for beta-ionone (for vitamin A) and for perfuming household preparations and detergents. Vetiver oil will be only for export purposes.

6.3 Pemba

Pemba does not offer scope for cultivation of essential oil bearing crops due to undulating area and lack of flat irrigated areas. However, as about 80 per cent of clove trees, more healthy than those in Zanzibar are located in Pemba, these offer a great scope for using clove leaves, fallen from the tree during its growth, from dead trees and from broken branches at the time of clove harvesting.

If even a part of the available leaf from the above sources is utilised, it would not be difficult to produce about 400 tonnes of the oil per annum. As mentioned elsewhere, this is only a problem of organising collection of clove leaves and their transportation to the site of distillation.

Clove leaf oil, which is the cheapest source of natural eugenol, can be converted into value added products like eugenol, iso-eugenol and vanillin. The oil can be used in the pharmaceutical industry, as such but preferably after suitable rectivication and/or isolation of eugenol both for Zanzibar and Tanzania Mainland.

7. Laboratory work done in Zanzibar

On arrival in Zanzibar, immediate assessment was made in determining facilities available in the Quality Control Laboratory of the Pharmaceutical Plant, Ministry of Health where Expert was expected to work. There

was hardly any apparatus for distillation of essential oil-bearing materials. Only one simple glass distillation flask, round bottomed, of 1000 ml capacity could be procured. Corks posed problems. At every step, innovation was done such as using Araldite (taken from India). Even the most basic and simple items posed great difficulties. For distillation of sufficient large quantities of aromatic plant material, a simple distillation unit made of galvanised iron sheet was designed and fabricated. Details of design of the main unit are given in Annexure XIX. This proved extremely handy and useful.

7.1 Distillation of aromatic plants

Collection of plant material posed great difficulty primarily for want of transport at regular intervals and when needed. However, work was carried out on the following materials.

i) Cardamom (true) Malabar variety

ii) Cinnamon leaf and bark (According to data on analysis of oils, the cinnamon does not seem to be true cinnamon i.e. Cinnamomum zeylanicum.

Leaf oil was poor in eugenol content while bark was rich in mucilage.

iii) Clove buds, stems and leaves.

Clove leaves were studied in greater detail and the work done is described separately.

iv) Eucalyptus species

v) Lemongrass. As per information available the species under cultivation as garden plant was West Indian type i.e. Cymbopogon citratus. Oil could not be evaluated for citral for want of sodium bisulphite.

vi) Lippea asperifolia

vii) Nutmeg

viii) Ocimum species

ix) Pimento (Allspice) leaves and berries at various stages of plant growth.

x) Vetiver

Analytical data on the above are summarised in Table 1 and 3. Information is also given in Chapter 2.4.

7.2 Clove Leaf Oil

Two major products are obtained in Zanzibar and Pemba from clove tree, i.e. cloves and clove stem oil. The latter is linked with the production of clove as stems are a by-product of cloves. On an average, availability of stems comes to about 20 per cent of the dry clove production.

Logically, clove and other products of the tree should command foremost attention for developing this industry further. Clove tree, besides clove, gives three different essential oils even if their main ingredient is eugenol. These are:

i. Clove bud oil and oleo-resin

ii. Clove stem oil and

iii. Clove leaf oil

These oils are used extensively, the leaf oil commanding the largest market. Estimated world demand of these three oils are:

Bud oil	about 50 tonnes
Stem oil	400-500 tonnes
Leaf oil	2000 tonnes and above

Generally, bud oil is produced mostly by the users abroad for getting oil with a particular note. Stem oil is a cheap replacement of bud oil and has a limited market. Leaf oil, the cheapest of the three, is extensively used not only as such, but also as a rectified oil, source of eugenol and other derivatives and as a starting material for high grade vanillin.

7.2.1 Plan of work

Clove tree in Zanzibar and Pemba is not exploited for leaf primarily due to the fear that tree becomes more susceptible to disease. The concerned Ministries are very particular about it. Due to this reason, attention of the Expert was concentrated on the leaves which fall down naturally during the course of vegetative growth of the plant. The leaves remain on the ground where these gradully decompose, ultimately providing humus to the soil. A study was, therefore, undertaken on the following:

i) Quantity of leaf which falls down during the course of the year.

ii) Quality of fallen leaves with respect to oil content and eugenol content thereof.

7.2.2 Quantity of leaf which falls down

To get an idea about the leaf which could become available after regular intervals, a medium size tree of about 40 year age was selected in Mwera (12 km from Zanzibar) from among a plantation of clove (The tree was isolated and there was no chance of leaves from other clove trees getting mixed into this collection). It was proposed to do a fortnightly collection which was later changed to collection at one month's interval due to acute transport problem.

It is understandable that the first collection would be a mixture of leaves of varying and inde terminate age, except that leaves fallen much earlier would have decayed becoming brittle, powdery and dark dirty brown in colour. First collection was, therefore, studied in greater detail to assess the advis ability of using such leaves for oil production; segregation could be done easily as colour and texture of leaves was observed to give ample indication of different ages of the leaves.

Fist collection leaves were sorted out in 3 grades:

Grade I	Still pale green in colour, intact leaves, healthy in appearance, without any sign of decay.
Grade II	Leaves still intact, light brownish in colour
Grade III	Leaves brittle, and partly decayed, dirty brownish in colour. Leaves break on touch and handling.

Grade I leaves were very few, while Grade II were predominant, followed by Grade III.

It was later on observed that leaf collections done at one month's interval were nearly all made up of Grade II type of leaves. (This grading was done visually without any difficulty). Data observed on oil content and quality are given in Table 2.

Other aspects of leaf collection studied were:

1. Leaves collected at random from under a cluster of clove trees after a continuous rain for a fortnight.
2. Leaves from broken branches of clove tree at the time of harvesting of cloves which lie scattered under the trees.
3. Leaves from dead tree of clove from disease which occurs in Zanzibar and Pemba frequently.
4. Leaves harvested from healthy tree for comparative study.
5. Dry leaves were collected from under a cluster of trees for commercial scale charge in the ZSTC distillary.

Data on all the above studies are summarised in Table 2. Analytical values are given in Table 3.

It is amply clear from the data on oil content and quality of oil from leaves of clove tree that leaves even if fairly older than one month and even after rains for a few days, give oil in economic yield and of good eugenol content. Leaves from dead tree of cloves were observed to be equally useful for production of oil

(Here, age of leaf is referred to the period elapsed after the leaves fall down from a tree)

7.2.3 Distillation of Clove Leaves

Essential oil of clove (bud, stem and leaf) being heavier than water poses some difficulty, particularly at the stage of separation after distillation. While in the laboratory, all the oil distilled can be recovered with the use of a solvent, the same is not practicable in the case of bulk distillation. Also, clove leaf being light in weight (more volume) will not permit complete exhaustion of the charge, if not packed tightly; loose packing gives rise to steam channelisation, steam passes out through the charge without extracting oil completely.

During distillation in metal distillation unit in the laboratory, it was observed that most of the oil settles down in the receiver, some oil remains dispersed in the distillate. Even with careful separation and distillation by cohobation, about 5 per cent oil remains in the distillate which settles down if distillate is kept overnight. Some oil sticks to the sides of the receivers. For maximum recovery of the oil, oil-free distillate should not only be returned to the distillation tank but also the distillate should be allowed to settle overnight. With this procedure practically all the oil can be recovered.

In our work in the laboratory, oil obtained directly as also obtained by solvent (washing the sides of the receiver) was examined for eugenol content. It was observed that eugenol content of the oil obtained through solvent was always less by about 2 per cent than that of the oil obtained directly.

It was further observed that the air dry clove leaves (moisture content about 10 per cent), if wetted slightly prior to distillation, not only permits more leaves to be packed in the same space in the distillation unit but the distillation time is also reduced by as much as 50 per cent.

On the other hand fresh leaves (green) take more time for distillation, about double the time needed to distil air dry leaves.

In case of large scale distillation, as the exhausted distillate will be returned back continuously to the distillation tank, oil recovery will be good. However, precaution and careful watch is absolutely necessa ry during the course of distillation.

A thousand litre capacity distillation unit can distil 150 to 160 kg of leaves in one charge.

7.2.4 Production Potential in Zanzibar & Pemba

Data obtained on oil content in leaf and quality of oil has shown a great promise and potential of leaf oil production. There are three promising sources of leaf collection and oil production on commercial scale in Zanzibar and Pemba.

i) Oil from leaves from dead trees

ii) Oil from leaves which fall naturally during the course of a year

iii) Oil from leaves from broken branches at harvest

Oil Potential From Dead Clove Trees — According to the estimate furnished by various sources, about 5 per cent trees die annually of diseases. The trees are cut down and used as fuel. According to another estimate about 32,000 ha. area is under clove trees, containing on an average 170 trees per hectare giving an overall number 54,40,000 trees in the islands; 5 per cent of which comes to 272,000 trees. Taking an average of 10 kg of dry leaves (much below actual), and an average oil content of 3 per cent, oil potential from dead trees alone comes to about 80 tonnes per annum.

Oil Potential from leaves which fall down naturally — According to

our studies, a medium growth clove tree of an age of about 40 years sheds about 25 kg (minimum) leaves (semi dry when picked) over a period of one year. In terms of oil this works out to a minimum of 3.75kg of oil per tree per year. However, in actual practice, considering various problems and constraints like collection and transportation, inclement weather, nature of terrain, even at 5 per cent of the potential can yield up to 200-250 tonnes of oil per year.

Oil Potential from Leaves of Broken Branches — It was observed during visit to various parts of the island that branches of trees are invariably broken while harvesting cloves; extent of such broken branches depends on the size of the tree and the terrain; more branches are broken in Pemba due to slopy and hilly terrain of the region. Taking a conservative estimate of even 1 kg of leaves per year per tree in 2 harvest, oil potential comes to about 150 tonnes per annum.

In all, about 400-500 tonnes of oil can be easily produced if concerted efforts are made. This comes to about 20 per cent of the current world production. Oil can be sold as such (being of better quality than Indonesian) or processed to eugenol, iso-eugenol and vanillin. (It must be, however, noted that vanillin production as a commercial proposition involves sophisticated technology. This aspect of recommendation should be considered only when sufficient infra-structure and local capability, both technological and commercial, becomes a reality).

Economic utilisation of easily available raw material from clove needs active and immediate consideration.

It will be seen from the above that Zanzibar & Pemba are in a position to produce sufficiently large quantities of clove leaf oil, which

as per the experience of the Expert, would be of a superior quality compared to Indonesian clove leaf oil. However, large scale production in the existing distillation units is expected to face some difficulty, mainly the transportation of leaves from the clove plantations to the distillery. Considering the distances, normally, it should not be difficult. But the islands are facing difficulties by way of vehicles, diesel and a few other bottlenecks which would come in the way of production of this oil using raw material which would otherwise go waste.

Expert considers it worthwile to set up small portable self-contained units costing about US $ 12,000 each capable of distilling about 1000 kg leaves during two shifts. One such unit should be installed in a selected clove area of a radius of about 5 km which would yield 6 to 9 tonnes of oil worth about $ 27,000 to $ 40,000 per annum. This trial is worth considering. In the initial stage 2 such units may be installed. Units can be procured from India.

8. Starch finds extensive use in may industries including pharmaceutical. Corn or maize is the most important source of starch; other sources are potatoes, cassava root, rice, wheat, etc. Corn contains 71 to 73 per cent of starch while other sources have lesser but economically viable content of starch. Various derivatives of starch are also manufactured for use in different industries. Starch is also used for production of dextrose and glucose by fermentation process.

Methods of producing starch from various raw materials are given in Annexure XX.

8.1 Scope of starch production in Zanzibar

In general, maize, cassava, potatoes which are the important food items in the developing countries are not available in regular and

sufficient quantities to be used for the production of starch. Zanzibar where cassava is an important crop is used for food purposes. However, a wild growing plant, Tacca involcurata (Fam. Taccaceae). syn. Tacca pinnatifida, commonly known as African, Tahiti or Fiji arrow-root, uwanga, Jike, is considered by the Expert important as a potential source of starch for the pharmaceutical industry.

Requirement of starch for use in the pharmaceutical industry in Zanzibar has been estimated at a minimum of 25 tonnes per year which is imported.

Local method of producing porridge (boko-boko) is to dig out the tacca tubers after the leaves of the plant die down. Tubers are reduced to pulp by grating on rough surface, washed and strained in a piece of cloth. Water with starch is collected and allowed to settle. Supernant water is decanted. More water is added and the process repeated several times. Starch so obtained is dried and is ready for use.

8.2 Production of Starch in the Laboratory

2.25 kg of Tacca tubers (fresh) gave 750 gm wet starch which on drying gave final product of 450 gm (Zero moisture content), i.e. an yield of 20 per cent. The processing is easy and yield economical for commercial production. Tacca starch resembles arrowroot starch, if properly prepared.

Due to lack of laboratory facilities, starch so produced could not be anaylysed. The Plant Manager was requested to send sample to the Expert in India for analysis to evaluate its possible utilisation in the pharmaceutical industry in Zanzibar.

8.3 Industrial Production

Production of starch from Tacca tubers would consist of essentially the following steps:

1. Cleaning and washing the tubers

2. Reducing the tubers to fine pulp

3. Filtering the material to remove pulp and fibrous material

4. Settling the milky juice to allow starch to settle

5. Decanting the wash and repeating the process till the wash is clear

6. Filtering the starch and drying

7. Powdering the dry starch to fine powder

For the production of 50 tonnes of starch annually, about 250 tonnes of Tacca tubers will be needed. A plant with a capacity to produce 25 kg of starch from about 1250 kg of tubers for day is considered adequate.

Flow sheet diagramm for manufacture of starch from Tacca tubers is given on page 69.

However, following information should be gathered in the first instance:

1. Availability of Tacca tubers from wild growth to support a production unit.

2. As the tubers will be harvested at a time, arrangements for storage during the processing period are to be ascertained.

9. Quality Standards for Essential Oils

Zanzibar and Pemba have a fairly large range of essential oil-bearing plants (vide Annexure II). These islands also hold promise of introducing a number of essential oil-bearing plants which can enhance its economy by not only utilising these oil in pharmaceutical preparations but also as export items. During the short stay of the Expert and considering various constraints in working on more essential oil-bearing plants (primarily for want of a transport) work on only about 16 plants could be done. Out of these plants, standards have already been laid down by various countries on the following:

1. Cinnamon leaf and bark oil

2. Corriander

3. Cardamom seed oil

4. Eucalyptus globulous and E. citriodara

5. Nutmeg

6. Pemento leaf and berry oil

7. Vetiver

Besides the above, standards on Methods of Sampling and Testing on Essential Oils are also available.

For ready reference list of standards formulated by India, Britain, and the International Organisation for Standardisation (ISO) on Essential Oils are listed in the Annexures XXII, XXIII and XXIV.

9.1 Fixing Standards for Quality Production and Maintenance of Essential Oils in Zanzibar:

Currently, only oil from clove stem is produced on a large scale. The oil produced is of good quality and standard. Lemon oil (distilled) was also produced sometime back. The Expert examined in great detail the possible utilisation of clove leaves for production of its oil. Various samples of oil were analysed and were found to be of reasonably good standard. Besides, work on various other oils was also done but not on sufficiently large samples to enable detailed evaluation. A major constraint in evaluation was lack of requisite apparatus, equipment and chemicals which inspite of the best efforts of all concerned could not be arranged during the project period.

As one of the main objectives of production of essential oils is their utilisation in the pharmaceuticals, it is essential and recommended that the oils conform to British Pharmacopoeia (BP) standards.

Some of the important essential oils and isolates for which BP

has given standards are:

Essential oil of : Anise, Caraway, Cardamom, Clove bud, Corriander, Dill, Eucalyptus (medicinal), Eugenol, Lavender, Lemon-Terpeneless, Menthol, Nutmeg, Orange, Orange-Terpeneless, Peppermint, Spearmint, Thymol, Turpentine.

B.P. specifications are given in Annexure XXV. Characteristics and analytical value of spices and spice oils are given in Annexure XXVI.

10. Analytical Methods

In the field of essential oils, two aspects are generally evaluated.

i) Physico-chemical characteristics

ii) Organo-leptic evaluation, i.e. odour and flavour.

While the first gives definite values of various characteristics, described hereafter in more detail , the latter is subjective but nevertheless of equal importance.

First and the foremost characteristic of an essential oil is its clarity, freedom from moisture and suspended matter. This is observed visually, but it is always advisable to treat the oil with anhydrous sodium sulphate, kept for sometime and filtered before subjecting to further analysis and evaluation. In some cases like clove oil which turn dark due to contamination at the time of distillation, treatment with 1 % solution of tartaric acid is given to improve colour. Important aspects of analysis of essential oils are given in Annexure XXVII.

11. Technology and Equipment Requirement

During the course of Assignment, the Expert involved fully Mr. Fatawi T. Fatawi (Counterpart) and Mrs. Maryam Amour in all the aspects of work. They were trained in the pre-treatment of material for distillation, distillation of material, recovery of oil from the

distillate, post treatment of crude oil and analysis thereof. To acquaint them with the method of solvent extraction, aromatic plant materials were also extracted with solvents and production of essential oils from Resinoids Eugenol was prepared from clove leaf oil distilled in the laboratory. Production of starch ex Tacca tubers was also demonstrated.

11.1 Distillation of Essential Oil-bearing Crops

Essential oils are volatile with steam and this property is made use of in their production from the plant material. Three types of hydro-distillation are practiced, viz.

i) Water distillation - in this case the material is immersed in water and distilled.

ii) Water and steam distillation - in this case material is placed above a grid, known as false bottom, while water is below the grid, on heating, only steam passes through the material.

iii) Steam distillation-in this case steam is generated separately and passed through the material.

Most of the plant materials are distilled preferably by water and steam distillation except materials such as rose, orange flowers and powdered almonds where water distillation is adopted. Out of these, steam distillation is more expensive as separate boiler is required to generate steam. Number i and ii have the advantage of portability, i.e. distillation units can be easily installed at any place where water is available. These also obviate expenses on transportation of bulky material over long distances to the site of distillery (In Zanzibar and Pemba, the third type of units are installed).

For the purpose of this Report, distillation procedure for the plants suggested for oil production are described only. The materials

are grouped into following categories:

1. Grasses from Cymbopogan species, e.g. citronella and lemon grass
2. Leafy material e.g. clove leaves, patchouli, and camphor, etc.
3. Seeds, e.g. cardamom, aniseed, fennel and caraway
4. Roots and rhizomes e.g. vetiver, curcuma
5. Barks e.g. cinnamon
6. Flowers

11.1.1 Grasses

Citronella and lemon grass are suggested for oil production due to the following reasons :

i) Surplus capacity of the existing steam distillation units which can be used without major modifications

ii) These crops fit into local soil conservation programme

iii) Large volume of these essential oils are traded the world over.

Harvested material is best left in the field for a day or two to allow moisture to evaporate. The material is distilled preferably after chopping which permits even and better packing in the units. However, unchopped material can also be distilled. Packing must be done evenly and in compact manner. Best method of charging is to divide the still body into two halves (depending on size) using a circular steel grid which can be removed. Still is filled up to 2/3 of the height and steel grid, with chains on its side, is lowered on top of the material. Further charging is continued which presses the material below the grid and comes down gradually. When the unit (upper half) is full it is pressed down by manual labour till no more material can be filled. Top lid is closed and steam injected.

Distillation is done without pressure.

In case of citronella, distillation should not be prolonged to recover all the oil, as it yields more oil but lower in quality with respect to its content of aldehyde (citronellal) and total acetylisable constituents. Loss in yield (recovery) of oil is fully compensated by improved quality of the oil.

In case of lemongrass, distillation should be completed to the last stage.

Oils from grasses are lighter than water and florentine receivers which separate these light oils should be used. After distillation, oil is removed from top of the receiver, allowed to settle for sometime, common salt or sodium sulphate is used to remove moisture, filtered and packed.

Oils should be packed in clean mild steel drums full to exclude air which, especially in the case of lemongrass, affects the oil quality adversely. As far as possible drums internally lacquered with epoxy resins or galvanised iron drums should be used, both of which are more expensive than mild iron drums.

11.1.2 Leafy material

In the case of leafy material, i.e. clove leaf, patchouli, camphor, and eucalyptus, conditions are different in each case, hence described separately.

i) Clove leaf ← In case of clove leaf, oil produced is heavier than water and thus needs more careful and patient treatment during separation of oil from oil water mixture. Process standardised by actual work has been described here. Clove leaves, air dried, to a

moisture content of about 10 per cent have been observed by the Expert to permit better distillation. Clove leaves being light in weight occupy more space, i.e. less material can be charged. On an average a unit of 1,000 litre capacity can take a charge of about 150-160 kg of dry leaves (moisture content 10 per cent). Moistening or wetting of leaves prior to distillation not only permits more leaves to be charged in the unit but has been observed to reduce time of distillation, in some case to half. Wetting of leaves is, therefore, considered adviseable prior to distillation.

(Water and steam distillation process was followed in the present work).

Oil-water mixture collected is allowed to stand for sometime when the oil settles down at the bottom of the receiver. After separation of oil, exhausted distillate was again charged into the unit, i.e. distillation was done by cohobation process. In case of distillation of large quantities, it is suggested to use two florentine receivers which will allow all the oil to separate, and the out-going water to be returned continuously to the still as it is not possible to separate all the oil unless water-oil mixture is allowed to settle down necessitating use of large tanks which is not practicable.

If distillation is done continuously, distillation is complete in 3 to 4 hours. Separated oil is freed from moisture by use of common salt or sodium sulphate, filtered and packed.

(In the laboratory work, where pilot scale distillation was done, it was observed that oil can be separated completely if careful handling is done. Oil removed by solvent from the last portions of the exhausted distillate and sides of receivers had lower eugenol content by about 2 per cent than that in the case of oil separated directly.

However, if all the care is taken, as much as 95-98 per cent of the oil can be easily separated. Oil losses will be minimum if the cohobation process is adopted.)

Clove leaf oil being rich in eugenol gets easily coloured when distilled in mild steel distillation units and packed in mild steel iron drums. However, industry is accustomed to the dark colour oil, as leaf oil being the cheapest of the three clove oils (i.e. leaf, stem and bud oil).

Oil, free from moisture and suspended matter, should be packed in clean metal drums of 200 litre capacity. Preferred standard sized containers are however, galvanised iron or epoxy-resin lacquered mild steel drums. For smaller lots, tin-lined or aluminium containers can be used.

ii) Patchouli — Patchouli is one of these essential oil-bearing crops where leaves after harvesting can be stored, after drying, for a long period which permits use of available distillation capacity to be utilised during the period when other crops are not available for distillation.

Patchouli, an expensive oil, is primarily accepted on its "odour" value and hence needs careful handling and distillation to avoid not only over heating during distillation but also avoiding any "odour" contamination especially if the unit is used for distillation of other plant materials.

Patchouli is best distilled using steam pressure of 30-40 PSI, lower pressure will prolong distillation while higher pressure might result in oil with dark colour and 'burnt' odour. It takes 16-20 hours to complete distillation. In case of patchouli, compounds contributing

to 'heavy' odour come towards end of distillation and complete distillation of leaves is, therefore, essential. Steam distillation gives better yield of oil thanwater and steam distillation.

Separation of patchouli oil in receiver should be attended to carefully as proper separation of oil from oil-water mixture takes time. Oil separated from receiver is freed from moisture, suspended matter and packed in clean, galvanised iron or epoxy-resin coated drums. As the oil is costly and used in perfume formulation, utmost care is required in handling oil at various stages to avoid odour contamination.

iii) Camphor-rich leafy material — In case of distillation of camphor-rich oil material, precaution is taken that camphor does not condense in the condenser. A specially designed condenser is recommended which permits easy collection of camphor since it comes over not only during the course of distillation but also what gets deposited in the condenser.

A design is appended with this Report (Annexure XXVIII)

iv) Eucalyptus Species — Procedure of distillation of eucalyptus leaves (with terminal branches) is the same both for medicinal and perfumery oils.

The material for distillation is allowed to dry for a day or two (avoiding direct sun drying) as it permits more packing and better yield from the same material. Eucalyptus oils are lighter than water, are easily separated in the florentine receivers and are, therefore, easy to handle. After separating from receivers, the oil is freed from moisture and any sediment or suspended material, and packed in 200-litre mild steel drums taking care to fill the drum full thus excluding air which especially in case of Eucalyptus citriodora can adversely affect the oil quality.

11.1.3 Seeds

Basically, all the seed materials are distilled immediately after grinding. Complete, unground, material should not be distilled as it not only takes longer to completely distil but also complete recovery of oil becomes difficult. Grinding too fine or too coarse is also avoided. Another precaution taken is regarding packing the material in the unit. It should not be very tightly or unevenly packed for it creates 'channelisation' with the result that all the material does not come in contact with steam resulting in low yield/recovery of oil.

In the case of cardamom oil, great precaution is required against 'odour' contamination as it is an expensive oil used in flavouring (and pharmaceuticals) where off-odours are not at all acceptable.

Oils should be stored in clean, odour free, drums after removing moisture and sediments/suspended materials. As the oils are expensive these should be packed in galvanised iron, aluminium, or epoxy resin lacquered drums of smaller capacity such as 5 to 20 kg.

11.1.4 Roots

Under this category, only distillation of vetiver roots is described.

Vetiver roots, harvested from vetiver plants of proper age are wetted and chopped. Unchopped roots can also be distilled but chopping is preferred. Distillation, if done by steam, is practiced at 50-70 PSI which brings over oil in much shorter period, normally about 12 hours. Water-steam distillation can take as long as 36 hours.

In case of vetiver distillation, the condensate can be of milky emulsion, in which case distillate is stored for separation of oil. Separation of oil-water mixture can pose problem. More than one

florentine receivers are used. Condenser water is run warm which helps in separation of oil-water mixture. Distillation is done by cohobation. Crude oil needs careful handling for producing good quality oil. Oil is freed from moisture, suspended material and packed in clean, odour free drums, preferably aluminium or epoxy lined iron drums.

11.1.5 Barks

In case of bark, cinnamon bark is discussed.

Normally, whole bark is distilled. Distillation can be done both by steam or water-steam distillation. Cohobation of distillate (free from oil) is necessary. In case of this material, as many as 5 florentine receivers may be necessary to use. Distillation water is stored for a long period (milky in colour) to enable oil to separate which settles down at the bottom wherefrom it is separated.

(In Zanzibar, the cinnamon bark available was thick and coarse containing a great deal of mucilage, which created problem in distillation. Bark was, therefore, ground and extracted with solvent. The resultant oleo-resin was water distilled which gave clear, good quality oil having characteristic 'bark' odour. The Expert does not consider the Zanzibar cinnamon as 'true' connamon).

11.1.6 Flowers

In this category only Ylang-ylang and Cananga are described.

Ylang ylang and cananga flowers are obtained from Cananga odorata Baill forma genuina and C. odorata Hook f.et. Thompson Syn. C. odorata Bail forma macrophylla. (Fam: Annonaceae). Out of these, Ylang ylang is considered superior. In this case, harvesting and post harvesting handling of material is very important.

Fresh flowers, harvested at night or early morning, without

bruising or broken give better quality oil. Harvesting of mature yellow coloured flowers should be done for distillation. Distillation is done by water distillation where flowers are immersed in water charging of flowers is done only when water starts boiling. This is an important precaution. It takes long time, 20-25 hours. In case of ylang ylang, oil is collected into 2 fractions, first being superior in quality. Distillation is done by cohobation. Distillation of ylang ylang is like fractionation of oil. Better quality oil rich in esters and ethers are collected as first fraction while oil rich in sesquiterpenes is collected as second fraction and sold separately.

Concrete of ylang ylang can also be produced which is used in fragrance industry.

11.2 Eugenol ex. Clove leaf oil

Extraction of eugenol is done by dissolving the oil in dilute aqueous solution of sodium hydroxide, separation of non-soluble portion of the oil and regeneration of eugenol by acid, purifying the crude eugenol either by vacuum distillation or steam/water distillation.

Procedure — Check eugenol content of the oil, prepare 3 per cent (W/W) aqueous solution of sodium hydroxide. Stronger solution creates problem of emulsion.

It is advisable to take a charge of 20 kg of oil.

Take 20 kg of oil (weighed) in a drum of 200 litre capacity. Add 3 per cent solution of alkali in lots and stir with wooden paddle. After adding 100 litres of alkali solution, check pH and at this stage add smaller quantities of alkali solution. For a good quality oil of about 90 per cent eugenol content about 125 litres solution of alkali will be needed. When the pH is alkaline, stir for about half an hour. Again

check pH. Large excess of alkali solution should be avoided.

Keep the mixture overnight and allow to settle. Non-eugenol portion of oil will come on the top. Carefully drain the lower aqueous alkaline layer in a separate drum. Wash the non-eugenol oily layer with about 5 litres of water. Allow to settle. Drain the aqueous layer and mix with the main aqueous - alkaline bulk.

Wash the aqueous alkaline bulk with benzene. Stir thoroughly. Allow to stand till benzene layer is clearly separated. Remove lower aqueous layer in a separate drum of 200 litre capacity. Repeat washing with benzene if necessary.

Take about 4 kg of concentrated hydrochloric acid. Dilute it 3 times. Add this diluted hydrochloric acid to the clear aqueous alkaline bulk with stirring till the medium becomes acidic. At this stage, all the eugenol will have been regenerated. Allow the material to stand for an overnight for eugenol to settle at the bottom. Remove eugenol and water-distil it in a stainless tank or distill under vacuum. This would give clear, nearly water-white or pale yellow eugenol. Add sodium sulphate and filter.

Recovery of pure eugenol will be about 95 per cent of the theoretical yield (as obtained by actual work). Check the product for specific gravity, optical rotation, refractive index, eugenol content, hydrocarbon content and solubility in 70 per cent alcohol.

The analysis should conform to B.P. (1979) Vol. I, p. 189-190.

Recovery of pure eugenol = $\frac{w \times c \times 95}{100}$

Where

W = weight of oil taken

C = eugenol content of the oil

Flow sheet diagram is also given in Annexure XXIX.

11.3 Oleo-resin from Chillies

Chillies generally contain :

Stalks	6 %
Pericarp	40 %
Seeds	54 %

Capsaicin, the principle constituent, and the colour are concentrated in the pericarp. Seeds contain mostly fatty oil with negligible pungency.

11.3.1 For the preparation of oleo-resin, the raw material is reduced to a moisture content of 6 to 7 per cent and ground to a coarse powder. Extraction is done by percolation with acetone or dichloroethylene. Acetone gives a product lower in fat and pigment but with a high capsaicin content. On an average, an yield of 6-7 per cent oleoresin is obtained.

Extraction is done in a single percolator or in a series of vessels connected for counter-current extraction. Extract thus obtained is transferred to a distillation appratus where the solvent is removed under vacuum. The residue i.e. oleo-resin thus obtained is a dark coloured product, viscous oil or semi-solid, depending on the raw material and the solvent used.

Equipment consists of the following:

i) Spice grinder (hammer mill),

ii) Extraction vessel (s), with trays to hold the charge,

iii) Stainless steel or glass, solvent extraction unit, with vacuum pump, and

iv) Solvent storage tank.

Evidently, the size of the equipment will depend on the charge/ production scale.

11.3.2 For ready reference, Indian Standards Institution requirement of Oleo-resin Chillies is given as under:

Characteristics	Requirement
1. Colour value (units)	4,000 to 20,000

2. Scoville heat units (min)	2,40,000
3. Capsaicin content, per cent by mass (min)	1.5
4. Residual solvent mg/kg (max.)	
a) Hexane	25
b) Acetone, chlorinated solvent	30
c) Methanol, iso-propanol	50

11.4 Anti-mosquito Cream

Antimosquito cream using citronella oil can be prepared as under:

Ingredients required (For 1 kg)

1. Emulsified wax	890 g
2. Glycerine	30 "
3. Citronella oil	50 "
4. Water	30 "

Melt emulsified wax. Add 50 g of citronella and keep the temperature at 60°C. Separately prepare a mixture of 30 parts each (by weight) of glycerine and water . Add slowly to molten wax, and stir well. When applied, the cream should not leave any stain.

In case pyrethrum extract (0.1 to 0.2 per cent by weight) is added, the anti-mosquito cream would be more effective.

Prepared cream may be packed in plastic containers of requisite size, in case collapsible tubes are not available.

11.5 Tinctures

Procedure for preparation of tinctures is well documented. However, for ready reference, preparation of tinctures, e.g. 1. Aromatic cardamom tincture, 2. Compound cardamon tincture, 3. Strong ginger tincture, 4. Weak ginger tincture, is given hereunder:

11.5.1 Aromatic cardamom tincture

For one litre preparation, mix

Cardamom oil	3 ml

Caraway oil	10 ml
Cinnamom oil	10 ml
Clove oil	10 ml
Strong Ginger tincture	60 ml

Add 90 per cent alcohol to make 1000 ml.

In Zanzibar, only caraway seed (to produce oil) or caraway oil will require to be imported. Other materials are available locally.

11.5.2 Compound Cardamom tincture

For one litre, mix

Cardamom oil	0.45 ml
Cochineal in moderately coarse powder form	7 g
Cinnamom oil	0.225 ml
Caraway oil	0.4 ml
Glycerol	50 ml

Add 60.3% alcohol to make 1000 ml

Moisten the cochineal with a sufficient quantity of alcohol and prepare 900 ml of tincture by percolation process. Add other ingredients and sufficient alcohol to produce the required volume. Mix and filter, if necessary.

11.5.3 Strong Ginger tincture

Ginger in moderately coarse powder	500 g
Alcohol 90 per cent to	1000 ml

Ginger tincture is prepared by percolation

11.5.4 Weak Ginger tincture is prepared by mixing 200 ml of strong ginger tincture in alcohol (90 per cent) and made up to 1000 ml.

Ginger syrup can also be prepared from strong ginger tincture.

12 Recommendations

Taking into consideration the needs of the Pharmaceutical Industry of Zanzibar and Pemba and based on the available information on the plants occurring both as cultivated and wild growth, and on the work done during the stay of the Expert, the following recommendations are made:

12.1 Items identified for production and analytical work

i) Immediate production

The following items can be taken up for production immediately (listed in order of priority):

Clove leaf oil

Eugenol ex. clove leaf oil

Cardamom oil & Tincture of cardamom

Cinnamom bark oil

Tincture ginger, both strong and weak

Tincture cinchona (material available in Tanzania Mainland)

(Tincture cardamom is imported in large quantities (1000 kg/annum); requirement will be more if locally available. For producing 1000 kg of the tincture, 10 litres of caraway oil and 7 kg of cochineal only will have to be imported annually. Alcohol is locally available).

ii) Future production - The following items can be produced if some work on cultivation and use of locally available material is undertaken.

Abelmoschus moschatus

Aniseed (Pimpinella anisum)

Cinnamon leaf oil

Citronella (Java type)

Caraway (Carum carvi)

Dill (Anethum graveolens)

Fennel

Patchouli (as intercrop)

Pimento (All spice)

Lemon grass

Nutmeg

Peppermint and Japanese mint

Vanilla

Vetiver

Ylang - Ylang and Cananga

(Citronella, lemongrass and vetiver recommended as soil conservation plants; Aniseed, dill, caraway and fennel to be raised as winter annuals; Mentha piperita and Japanese mint may also be tried).

iii) Oleo-resins of the following are suggested :

Capsicum (Zanzibar was once famous for its chillies)

Ginger

Pepper

iv) A large number of flower bearing and other aromatic plants occur in the islands which could be exploited for concretes and essential oils. However, laboratory work is to be taken up in the first instance, for which the following plants are identified :

Acacia farnesiana

Atrobotrys odoratissimus

Barringtonia racemosa

Bauhinia acuminata

Michelia champaka

Polyalthia longofolia

Pandanus spp

V) Screening of the essential oil - bearing plants growing in the islands, both for oil content, quality and commercial production.

a) Priority I

Afromomum augustifolia

Cinnamomum camphora

Citrus species for both peel and leaf (pettitgrain) oils

Eucalyptus species

Melaleuca leucodendron (cajeput)

Ocimum species especially O.canum (camphor type - observed by the Expert growing wild in Pemba).

b) Priority II.

Allium cepa

A. porrum (Leek)

A. schoenoprasum (chives)

Cinnamon species

Curcuma longa

Lippia asperifolia

Moringa oleifera (both for fixed oil and root oil which resembles horse-radish oil)

Ocimum viride

Salvia species

vi) Miscellaneous plants and products

a) Following plants hold promise of economic use and are recommended for active consideration:

Aloes

Azadirachta indica (Neem)

Castor (Ricinus communis)

Datura metal

Hydnocarpus (Chaulmoogra)

Papaya for Papain

Starch ex. Tacca involcurata

Anti-mosquito cream (either from citronella recommended for introduction or diethlphthalate to be imported).

b) Further work on the following plants is required which would be helpful in their utilisation.

Flagellaria guineesis

Ipomea pes - capris

Jatropha curcus

Momordica charanta

Mucana pruirens

Rauwolfia mombasiana

c) Following plants have good insecticidal and insect repellant properties commonly used by the people.

Polypodium scolopendris (Fern)

Tephrosia vogillii

12.2 a) Laboratory Equipment, Chemicals and Appratus.

Laboratory equipment, chemicals and apparatus are lacking for work on essential oil-bearing plants and essential oils. A list is appended (Annexure V). It is strongly recommended that these items should be procured as soon as possible so that work on the evaluation of essential oils is not hindered.

b) For distillation in the laboratory a distillation unit with a capacity of about 5-10 kg material is suggested. As a boiler is being installed in the Pharmaceutical Plant, it is strongly recommended that a unit of about 200 kg capacity be installed in the Plant for trial distillation. Design of a distillation unit of capacity 300 kg for water-steam distillation to be used under field conditions is also given given (Annexure XXXI). Designs of these units are given in Annexure XXX, XXXI and XXXII .

12.3 As mentioned in Chapter 11, Mr. Fatawi T. Fatawi and Ms. Maryam Amour were fully involved in all the aspects of work on essential oil-bearing plants during the stay of the Expert and work done there. However, due to limitation of time, constraints in procuring material which came in way of doing more work, these workers could not be exposed to production oriented work on various plants. According to the Expert, these workers should be able to carry on work in the laboratory. However, it is the 'show-how' of the 'know-how' which would give them confidence. It is, therefore, recommended that suitable candidates be enabled to see large scale production of essential oils in some developing country like India for about 4 weeks.

The Plant Manager, Pharmaceutical Plant, Min. of Health, was connected with the work of the Expert. It is recommended that a most suitable person be exposed to work of production of essential oils and their utilisation as he will be ultimately responsible for utilisation of these products in his country He may be sent for a study tour of distillation and production units engaged in the field of essential oils in a country like India for 10-15 days. The Expert can help in this study tour.

12.4 List of Books and Standards considered useful forkwork in Zanzibar are given hereunder:

1. Y. Masada	"Analysis of Essential Oils by Gas Chromatography and Mass Spectrometry", (Wiley, New York) 1976,
	"Analysis of Essential Oils by Gas Chromatography", (Kriokawa Publ. Co., Tokyo) 1968.
2. C.K. Atal & B.M. Kapur	"Cultivation and utilisation of Aromatic Plants" 1982
	Cultivation and Utilization of Medicinal Plants" 1982 (Regional Research Laboratory) Jammu - 180001.
	Rs 180 (For the above 2 volumes)

3. The Essential oils — E. Guenther, Vol I-VI (Robert E. Krieger Publishing Company, Huntington, New York) 1972

4. S. Arctander — Perfumery and Flavour Materials from Natural Origin, Elizabeth, N.J. U.S.A.

5. Standards Published by :

i) British Standards Institution

ii) Indian Standards Institution

iii) International Standards Organisation

iv) Essential Oils Association of U.S.A.

Unido may consider procuring these for reference and use in this work in Zanzibar.

13. List of Officials & Specialists met during the assignment

Zanzibar

1.	Mr. M. I. Hassan	Assistant Minister, Ministry of Health
2.	Mr. Juma Dhuni	Assistant Minister, Planning Z'bar
3.	Mr. Talib Mahadehi Ali	Plant Manager, Pharmaceutical Plant, Min. of Health
4.	Mr. Juma Ame	Director of Hospital Services, Min. of Health
5.	Mr. Abdullo Mbwaka	Director of Planning & Development, Min. of Health
6.	Mr. P. Awe	Chief Pharmacist, Min. of Health
7.	Mr. Abbass Seif Abbass	Production Manager, Pharmaceutical Plant, Min. of Health
8.	" Abdullah J. Kunduri	Ministry of Education
9.	" Yusuf O.K. Hassania	FAO/Consultant, Ministry of Agriculture
10.	" Seif Rashid	Director of Agriculture, Min. of Agriculture
11.	" Abdul Hamid	Agricultural Officer, Min. of Agriculture
12.	Mr. Musa Makame	Marketing Manager (Acting) ZSTC
13.	Mr. Musa Khamis	Govt Chemist, Min. of Agriculture

Pemba

1.	Mr. Seif Masoud Seif	Regional Health Office South, P.O. Box 201, Chake Chake Pemba - E. Africa
2.	" Mtumua Ubua Mdoe	Regional MCH Co-ordinator, South, P.O. Box 201 Chake Chake, Pemba - E.Africa
3.	" Burhan Omar Muhammed	Electical Engineer, Clove Stem Oil Distillery Chake Chake
4.	Dr. Hassan Ameir	Regional Medical Officer, South Chake Chake, Pemba
5.	Dr. Cham Othman	Regional Medical Officer, North Wete, Pemba

6. Miscellaneous

Traditional Medicine Practitioners : (Eight were interviewed)

i. Mr. Hamad Omar Juma

Vitongoji Unandavi
Vilougoji, Chake, Pemba.

ii. Mr. Mattav Salim Mattoo
Minazina Kengeja
Pemba

iii. Mr. Haji Said Khamis
Mkumbi, Kengeje, Pemba

iv. Mr. Ubua Ali
Tasam, Makunduchi
Zanzibar,

LITERATURE CONSULTED

1. Martindale — "The Extra Pharmacopoeia" 27th Ed., (The Pharmaceutical Press, 1 Lambeth High Street, SE1) London, June 1979.

2. R.N. Chopra, S.L. Nayar & I.C. Chopra — "Glossary of Indian Medicinal Plants" (Council of Scientific & Industrial Research) New Delhi 1956; Supplement to Glossary of Indian Medicinal Plants, 1969.

3. R.O. Williams — "The useful and Ornamental Plants of Zanzibar and Pemba" (St. Anne's Press, Limperley) Altrincham, 1949.

4. J.M. Watt., & M.G. Breyer-Brandwijk — "The Medicinal and Poisonous Plants of Southern and Eastern Africa" 2nd Ed. (E & S. Livingstone Ltd.) Edinburgh and London 1962.

5. - British Pharmacopoeia, 1, Vol. I and Vol. II, (Her Majesty Stationery Office) London, 1980.

6. - Perfumer & Flavorist, various issues

7. J.K. Atal & B.M. Kapur — Cultivation and utilisation of Aromatic Plants. Cultivation and utilisation of Medicinal Plants (Regional Research Laboratory, Jammu) 1982.

8. Brian M. Lawrence — Perfumer and Flavorist 1, Dec/Jan, 1977, 15-26

9. - The Pharmaceutical Codex Incorporating the British Pharmaceutical Codex. Eleventh Edition (The Pharmaceutical Press; London) 1979.

10. J.S. Pruthi — Spices and condiments (National Book Trust, India, New Delhi) 1979.

Table - 1. WORK DONE ON THE EVALUATION OF ESSENTIAL OIL BEARING PLANTS

	Plant	Part of the Plant Distilled	Distillation done on	Oil content on (Percent-by weight) Fresh weight	Semidry weight	Zero moisture Basis	Remarks
1.	Cardamom Small (Malabar variety)	Seeds (crushed)	LS	-	i) 5.3 ii) 3.9	- -	Fresh Sample Old Sample
2.	Cinnamon	Bark (Whole)	LS	-	1.7	-	Resinoid 2.1%
3.	Cinnamon	Leaves	RS	0.9	1.2	1.8	-
4.	Clove	Buds	LS	-	16.2	-	-
5.	Clove	Leaves	Please see Table 2	-			
6.	Clove	Stems	LS	-	4.1	-	Distillation incomplete
7.	Eucalyptus soligna	Leaves	RS	-	0.07	0.14	-
8.	Eucalyptus zonzi-baricum.	Leaves	RS	-	Traces	-	-
9.	Lemongrass Cymbopogon citratus)	Leaves	RS	-	0.64	0.96	-
10.	Lippea asperifolia	Leaves	LS	-	1.00	1.25	-
11.	Nutmeg	Leaves	LS	-	Traces	-	-
12.	Ocimum americanum	Fresh leaves and flowering stalks	LS	-	0.46	0.69	-
13.	Ocimum (local name Rehani)-unidentified	Whole Plant	LS	0.40	0.60	2.20	Seems rich in Methyl cinnamate.

14. Ocimum spp. (unidentified)	Fresh Flowering whole plant	IS	2.30	-	4.0	-
15. Ocimum sauve	-do-	IS	0.70	-	2.30	Contains eugenol as chief component
16. Pimento(Allspice)						
a) Inflorescens stage.	i)Leaves	IS	2.2	2.7	-	Leaves harvested from the tree.
	ii) Inflorescens		-	3.6	-	
	iii) Stalks		-	Traces	-	
b) Fruiting stage	i) Leaves	RS	-	1.55	1.90	Leaves harvested from the tree.
	ii) Immature berries	IS	-	2.48	3.70	
c) Fruiting Stage (ripe berries)	i) Leaves	RS	-	1.18	1.30	Old leaves from under the trees
	ii) Leaves	RS	Rs	1.50	1.70	Leaves freshly fallen from trees.
	iii) Mature berries	RS	-	1.45	1.9	
17. Vetiver	Roots	IS	-	1.2	-	Resinoid with: Alcohol 6% Benzene 3%

N.B.: IS = Distilled in 1000 ml glass assembly

RS = Distilled in 75 litre capacity metal distillation unit

Samples of coriander and vanilla beans supplied by Mr. Hassania of Agricultural Ministry were very old and no volatile matter could be obtained.

Table -2 : WORK DONE ON THE EVALUATION OF CLOVE LEAF

Leaves From	Moisture Content	Distillation done on		Oil Content on (Percent by weight) Semidry basis	Dry weight basis	Eugenol content(%) V/V	Remarks
1. Random Collection							Mixed Plantation
Site : Mwera							
a) Grade I	15	IS		4.0	4.7	-	-
b) Grade II	11	IS	i)	5.7	6.4	-	-
			ii)	4.9	5.5	-	-
		RS	i)	4.5	5.0	83	
c) Grade III	11	IS		3.50	3.9	81.8	Distillation incomplete
		RS		4.5	5.0	85	-
Site : Donge							Pure Plantation Leaves rain soaked
i) Distilled immediately after collection	50	RS		1.7	3.4	80	
ii) Distilled after air drying	25	RS		2.8	3.7	84	
iii) Air dry leaves collected for bulk distillation in ZSTC distillery	11	RS	i)	3.3	3.7	87	Interrupted for want of water
			ii)	4.0	4.5	81	-
iv) Bulk distillation in the ZSTC distillery (130 Kg leaves)	10	-		2.6	2.9	82	Steam-oil vapour leaked heavily, condenser water was hot resulting in low yield of oil.

2.	Collection from under a single Tree					
	1) Site: Mvera					
	i) First Collection	11	RS	2.35	2.64	85	Leaves of all ages; air dried in laboratory
	ii) Second collection	11	RS	3.8	4.2	82	Leaves age not more than one month
	iii) Third collection	10.6	RS	3.4	3.8	88	- do -
	iv) Fourth collection	9.6	RS	3.6	4.0	83	Age of leaves 5 weeks
	2) Kizimbani					
	1) First collection	10	RS	5.6	6.2	82	Leaves from trees of various age group distilled collectively
	2) Second	10	RS	4.3	4.8	82	- do -
			LS	4.5	5.0	-	Tree age 30-40 year
			LS	7.65	8.5	-	Tree age 40-60 year
3.	Miscellaneous					
	i) Leaves harvested from a tree	33.0	LS	2.0	3.2	-	
	ii) Leaves from broken branches of tree - during clove harvesting	50.0	RS	3.9	7.8	84	
	iii) Leaves from dead tree	16.0	LS	4.1	4.9	90	
		16.0	RS	5.7	6.9	84	Leaves collected from a dead tree, 20 year of age.

NOTE: LS: Leaves distilled in glass assembly of one litre capacity.
RS: Leaves distilled in metal distil ation unit of 75 litres capacity

Table - 3:

OIL SAMPLE FROM

Random Collection:

i) Grade II

ii) Mixed Grades

iii) Grade III

Site: Donge:

i) Leaves distilled immediately after collection

ii) Distilled after air drying

iii) Air dry leaves collected for bulk distillation in ZSTC distillary

iv) Bulk distillation in ZSTC Distillary

Collection from under a single tree

Site: Mvera:

i) First collection

ii) Second collection

iii) Third collection

iv) Fourth collection

Site: Kizimbani

1) First collection

2) Second collection

Miscellaneous

i) Leaves from broken branches

ii) Leaves from dead tree

N.B: (Please refer to Table-2 also;

ANALYSIS OF SAMPLES OF CLOVE LEAF OIL

OPTICAL ROTATION	SPECIFIC GRAVITY 30°C	SOLUBILITY IN 70% ALCOHOL (29°C)	EUGENOL CONTENT V/V (%)
-	1.0419	1 :1.3	83%
-	1.0412	1 :1.1	85%
-	-	1 :1.4	96%
-2° 12'	1.029	1 :1.3	80%
-2°	1.033	1 :1.2	84%
-	1.0311	1 :1.2	85%
-	1.0290	1 :1.1	83%
-1° 45'	1.0419	1 :1.5	89%
-1° 50'	1.0344	1 :1.2	82%
-2°	1.0344	1 :1.2	88%
-1° 57'	1.0344	1 :1.2	82%
-2°	1.0274	1 :1.3	80%
-1° 51'	1.0344	1 :1.1	82%
-1° 39'	1.0330	1 :1.5	84
-1° 45'	1.0390	1 :1.3	83

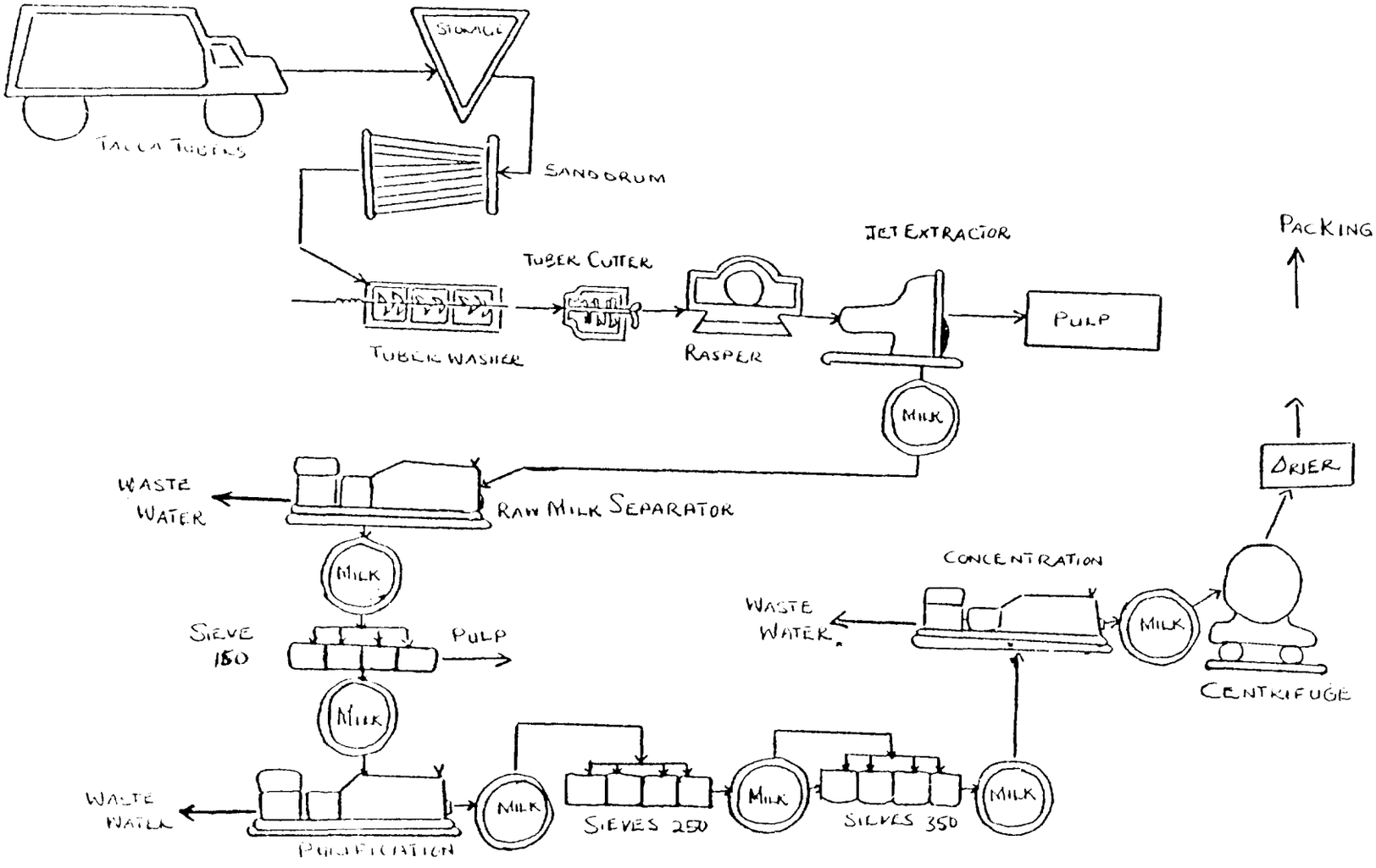
STC= Zanzibar State Trading Corporation)

		Analysis of Essential
1)	Pimento leaves oil	-
2)	Pimento leaves oil	-2^{c}
3)	Pimento beries oil	-
4)	Cinnamom leaves oil	-
5)	Cardamom [illegible]d oil	-
6)	Lemon grass oil	-15^{o}
7)	Eugenol of Pimento	-
8)	Eugenol of clove leaf oil (refined)	-15
9)	Non-eugenol of Pimento (Crude)	-
10)	Non eugenol of clove (refined)	-12^{o}
11)	Eugenol clove leaves (refined)	-
12)	Non-eugenol of Pimento (refined)	-
13)	Oil of Anis	-9^{0}

oils (other than clove leaf)

0.9834	1 :1.2	52% (Eugenol V/V)
0.9791	1 :2.1	68% (Eugenol V/V)
0.9664	1 :1.3	65% (Eugenol V/V)
-	Insoluble	50% (Eugenol V/V)
-	1 :3	-
0.9062	Not soluble	-
-	1 :1.5	-
1.0638	1 :1.5	-
-	Insoluble up to 10 vols.	-
0.9242	do	-
1.0637	1 :1.2	-
-	Insoluble upto 10 vol.	-
-	-	-

STARCH FROM TACCA TUBERS



P A R T T W O

ANNEXURES

Annexure - I

SI/URT/82/803/11-01- UTILISATION OF PLANT RESOURCES IN PHARMACEUTICAL PRODUCTION.

(PRELIMINARY STUDIES)

TENTATIVE SKELETON PROGRAMME:

ACTIVITES:

Of the six months provided, four will be spent in Zanzibar and one in Pemba in field work and the 6th month will be spent in Zanzibar in the compiling and preparation of the reports.

The work scheduled to start in the second week of October will be carried out on weekly basis. Two days of the week will be spent in country-side visits to examine the habitats and location of the plants and for collection of samples as well as for discussions with local herbalist who, are expected to contribute some useful and guiding information.

The remaining days of the week will be spent at the station for documentary work and analysis.

PARTICIPANTS.

1. Dr. Gulati - the UNIDO expert
2. Mr. Fatawi - the Counterpart
3. Mr. Suleiman - (appointed to assist during countryside visits).
4. A representative of Ministry of Education
5. A representative of Forestry Department, Ministry of Natural Resources.
6. Mr. Yusuf Hasania - from Ministry of Agriculture for technical consultation.
7. Mr. Mussa Khamis - (from Ministry of Agriculture as part time participant for technical consultations)
8. Administrative Heads of the Regions and Areas also of the Ministry of Health.

AREAS TO BE VISITED:

ZANZIBAR:

1. South
2. Central
3. North D
4. North A
5. West

PEMBA:

1. Mkoani
2. Chake
3. Wete
4. Michewani

PLACES TO BE VISITED:

ZANZIBAR:

SOUTH

Maweni
Jozani
South Coast

CENTRAL:

Bambi (east)
Uroa
Chawaka
Koani

NORTH B:

Mangapwani
Kiwengwa
Makoba
Kinyasini
Pangeni

NORTH A	Matemwe
	Tumbatu
	Chaani Masingini
	Pwani Mchangani
WEST	Fumba
	Chukwani
	Masingini
	Fuoni
	Kizimbani
	Grave Island
	Botanical Garden(Mazizini)
PEMBA	
Mkoani:	Kisiwa Panza, Mkoani, Kengeja
Chake:	Vitongoji, Ziwani.
Wete:	Ntambile, Piki, Pandani, Fundo.
Micheweni:	Tumbe, Ngezi, Kiuyu, M/Ngombe
	Kigomasha.

N.B. The detailed final programme will be prepared when the UNIDO expert arrives.

ESSENTIAL OIL - BEARING PLANTS (INCLUDING SPICE

Sr. No.	Botanical Name and Family	Local name
1.	Acacia farnesiana Willd (Leguminoseae)	Mk ha Mbica
2.	Afromomum angustifolium k. Schum (Zingiberaceae)	Matunguu
3.	Allium species (Liliaceae)	
i)	A. ascalonicum	Shallot Kitunguu
ii)	A. cepa L.	Onion Kitunguu
iii)	A. porrum L.	Leek
iv)	A. schoenaprasum L.	Chives
4.	Apium graveolens L. (Umbelliferae)	
5.	Atrobtyra odorotissimus (Annonaceae)	Climbing Ylang-Ylang

& CONDIMENT PLANTS) OF ZANZIBAR AND PEMBA.

Nature of Growth	Part of Plant used	Common name of Product and uses in Industry
Cultivated	Flowers	Cassia concrete and absolute. Fragrance
Wild	Seeds	-
Cultivated	Bulbs	-
Cultivated	Bulbs	Onion oil. Flavour
Cultivated	Bulbs	Leek oil & Oleoresin. Flavour
Cultivated	Bulbs	
Garden Plant		Celery Oil & Oleoresin. Flavour
Cultivated	Flowers	-

Annexure

6.	Barringtonia racemosa Blume ex. DC (Lecythidaceae)	Mtondoo
7.	Bauhinia acuminata (Caesalpiniaceae)	-
8.	Cananga odorata var. macrophylla Hook f.et. Thompson C. odorata Bail forma genuina (Anonaceae)	Ilang-Ilang
9.	Capsicum annuum & C. frutescens (Solanaceae)	Sweet pepper, mpilipili Bird pepper, mpilipili hoho
10.	Cinnamomum camphora Sieb	Camphor
11.	Cinnamomum verum Presl. (Lauraecae)	Cinnamon, Mdalasini
12.	Citrus spp. (Rutaceae)	
	i) Citrus aurantifolia Swingle	Lime, Ndimu
	ii) C. aurantifolia (variety)	Tahiti or Persian lime, Ndimu Maskati

Wild	Flowers (very large, fragrant)	-
Wild	Flowers (very large, fragrant)	-
Cultivated	Flowers	Cananga and Ylang-ylang Fragrance
Cultivated	Fruit	Capsicum oleoresin, Flavour and Pharmaceuticals.
Cultivated	Leaves, twigs, wood, root	Camphor & camphor oil. Pharmaceuticals & Industrial.
Cultivated	Bark, leaves	Cinnamon bark & leaf oil. Flavour, fragrance & medicinal.
Cultivated	Fruit	Distilled oil, expressed oil. Flavour.
Cultivated	Fruit	-

iii)	C. aurantium L. a) Sour variety	Seville orange, Bigarde orange, sour orange, Mkalingombe, Mlanzi
	b) Sweet variety	Mlanzi Kisilamati
iv)	C. limonia Burm. f.	Sweet lemon, Mlimau
v)	C. japonica	Kumquat
vi)	C. maxima (Burm.) Merr.	Shaddock, Pomelo, forbidden fruit, Mbalungi
vii)	C. nobilis and several local varieties	Mandarin, Tangerine Mchenza wa kiajemi (best variety) chenza kingaja
viii)	C. paradisi Macf, (many varieties).	Grape fruit
ix)	C. Sinensis Osbeck	Sweet orange, mchungwa
x)	Citrus plants (unidentified)	Sweet lime, Mdimu mtamu
13.	Coleus barbeatus Benth (Labiateae)	Spanish thyme, Mzungwa

Cultivated	Fruit	Oil from peel, flower & leaf. Fragrance, Flavour.
Cultivated	Fruit	Peel oil. Flavour
Cultivated	Fruit	Oil from peels, Flavour
Cultivated	Fruit	-
Cultivated	Fruit	-
Cultivated	Fruit	Essential Oil. Flavour
Cultivated	Fruit	-
Cultivated	Fruit	-
Cultivated	Fruit	-
Cultivated as garden plant	Leaves	-

14.	Curcuma longa Linn (Zingiberaceae)	Turmeric Manjano
15.	Cymbopogon citratus Stapf (Gramineae)	Lemon grass
16.	Elettaria cardamomum var. minuscula. Linn. (Maton) (Zingiberaceae)	Iliki, Cardamon
17.	Eucalyptus spp. (Myrtaceae)	
i)	E. citriodora Hook	Lemon scented gum
ii)	E. crebra F.v.M.	-
iii)	E. paniculata Sm.	-
iv)	E. rostrata	-
v)	E. robusta Sm.	Swamp mahogany
vi)	E. soligna Sm.	-
18.	Eugenia spp. (Myrtaceae)	
i)	Eugenia aromtica Kuntz. Syn. E. carryophylliata. Thunle	Clove, mkarafuu
ii)	E. cumini syn. E. jumbolana lam.	Java plum, Mzambarau

Cultivated	Rhizomes	Flavour & colouring matter. Curcuma oil, curcumin and oleoresin.
Cultivated	Leaves	Lemon grass oil. Flavour, fragrance & pharmaceutical
Cultivated	Fruit	Cardamon oil. Flavour, pharmaceutical and fragrance
Cultivated	Leaves & twigs	Citriodora oil. Fragrance
Cultivated	-	-
-	-	-
Cultivated	-	-
-	-	-
-	-	-
Cultivated	Buds, stems, leaves	Clove bud, stem & leaf oil, clove oleoresin. Flavour, Fragrance and pharmaceutical
Cultivated	Fruit	-

iii)	E. jambos Linn.	Rose apple, Pomme Rose, Mgulabi, Mpera wakizungu, Mrashi wa kizungu, Mrashi, Mpera julabi
iv)	E. javanica	Nex jambu, mtofaa mwepe
v)	E. malaccensis	Pomme malac, Pomerac, Mtofaa
vi)	E.uniflora	Surinam cherry, Pitanga
19.	Hibiscus abelmoschus Linn. (Malvaceae)	Musk okra
20.	Lippea asperifolia A. Rich syn. L. javanica Spreng (Verbenaceae)	Mpambake
21.	Melaleuca leucodendron Linn. (Myrtaceae)	Bottle bush
22.	Mentha viridis Linn (Labiateae)	Mint, Mnanaa
23.	Michelia champaca Linn. (Magnoliaceae)	Champac

Cultivated	Fruit	-
Cultivated	Fruit (and ornamental)	-
-	-	-
Cultivated	-	-
Cultivated	Seeds	Ambrette oil
Wild	Leaves	-
Wild	Leaves & twigs	Cajeput oil
Cultivated	Whole flowering plant	Spearmint oil. Flavour and pharmaceutical
Cultivated	Flowers	Fragrance

24.	Moringa oleifera Lam.Syn. M. pterygosperma Gaertn. (Moringaceae)	Mronge
25	Murraya koenigii Spreng (Rutaceae)	Curry leaf, Mvuje
26.	Myristica fragrans Houtt. (Myristaceae)	Nutmeg, Mkungu manga
27.	Petroselinum crispum (Mill) Nym. ex. auct Kew (Umbeliferae)	Parsley
28.	Pimenta recemosa (Myrtaceae)	Pimento, Allspice
29.	Piper betel Linn. (Piperaceae)	Betel pepper, Mtambuu
30.	Piper nigrum Linn. (Piperaceae)	Black pepper, Mpilipili manga
31.	Polianthus tuberosa Linn. (Amaryllidaceae)	Tuberose
32.	Polyalthelia longifolia Benth. & Hook. f. (Annonaceae)	Tuberose

Wild	Roots, horse radish sm.	Fixed oil from fruits,)flower & root oil could be useful in fragrance and flavour industry. (Opinion of the Expert).
Cultivated	Leaves	Flavour
Cultivated	Fruits, leaf	Nutmeg & mace oil. Flavour, Pharmaceutical
Garden plant	Fruits, leaf	Parsley leaf and seed oil. Flavour
Cultivated	Leaves and berries	Allspice. Flavour, Pharmaceutical.
Cultivated	Leaves	Medicinal and flavour
Cultivated	Fruits	Pepper oil & oleoresin. Flavour
Cultivated	Flowers	Tuberose concrete & absolute. Fragrance.
Cultivated	Flowers	-

33.	Ocimum spp. (Labiateae)	
i)	Ocimum americanum Linn.	Kivumbasi
ii)	Ocimum suave Wild	Mtule
iii)	Ocimum viride Wild	Mzamda
iv)	Ocimum spp. (unidentified)	Mrehani
34.	Pandanus spp. (Pandanaceae)	Mkadi
35.	Salvia spp. (Labiateae)	
i)	S. farinaceae	-
ii)	S. officinalis Linn.	Sage
iii)	S. splendens	-
36.	Triphasia trifolia (Rutaceae)	Myrtle lime Mdimu wa Shina
37.	Thymus vulgaris Linn. (Labiateae)	Thyme
38.	Vanilla planifolia Andrews (Orchidaceae)	Vanila
39.	Vetiveria zizanioides Linn. (Nash) (Graminaea)	Mzumari, Vetiver
40.	Zingiber officinalis Rosc. (Zingiberaceae)	Ginger Mtangawizi

Wild	Whole plant	-
Wild	Whole plant	-
Wild	Whole plant	Oil rich in thymol
Wild	Whole plant	-
Wild	Flowers	Kewda products. Flavours
Wild	Flowers	-
Cultivated	Leaves	Sage oil. Flavour
Wild	-	-
Cultivated	Fruits, Flowers	Essential oil
Garden plant	Whole plant	Thyme oil. Flavour
Cultivated	Beans (Cured)	Vanilla. Flavour
Wild	Root	Vetiver oil. Fragrance
Cultivated	Rhizome	Ginger oil & oleoresin, Flavour, Fragrance, Pharmaceutical.

Cultivated Plants

	Botanical Name	Family:	Local/Common Name
1.	Areca catechu Linn.	Palmae	Betel nut, areca nut
2.	Cannabis sativa Linn.	Canna binaceae	Indian hemp, ganja
3.	Carica papaya Linn.	Caricaceae	Paw paw, papaya

ZANZIBAR AND PEMBA

Uses	Pharmacopoeias
Nuts astringent; used in dysentry & for worms in dogs. Formerly employed as decoction (1 in 10) or enema (1 in 20) for tapeworm infestation; sialagogue properties; now used as a masticatory.	BPC 1949; Aust.P Chin. P., Jap. P.
Dried flowe tops of female plant, intoxicating; narcotic when smoked; resin commonly known as hashish and charas. A series of cannabonoids extracted from the drug. Cannabis was formely employed as sedative or narcotic but rarely used now.	BPC 1949, Indian Portugese, Spainish Pharmacopoeias.
A proteolytic enzyme or mixture of enzymes prepared from the juice of unripe fruit of the plant Papain consists chiefly of a mixture of papain and chymopapain, proteolytic enzymes. It is widely used as a meat tenderiser and in clarification of beverage, pharmaceuticals	Papain: FBC 1954;Arg; Braz;, Ind. and Italy.

Annexure III

4.	*Cinnamomum camphora* Nees & Eberm	Lauraceae	Camphor tree
5.	*Cassia fistula* Linn.	Leguminosae	Purging cassia
6.	*Cola acuminata* Schott. et Endl.	Sterculiacea	Kola nut
7.	*Cymbopogon citratus* Stapf.	Gramineae	Lemon grass oil

Camphor taken internally is irritant and carminative, has been used as mild expectorant to relieve griping. Externally, it acts as a rubefacient, mild analgesic, employed in linements as a counter-irritant in fibrositis, neuralgia and similar conditions. Camphor oil,, after removal of camphor has been applied externally, mixed with oil or as such as a mild counter irritant and in treatment of rheumatic affections.	Camphor in practically all pharmacopoeias
Aqueous percolate of crusted ripe cassia fruit (cassia pods) evaporated to soft extract as purgative. It is rarely used alone.	BPC. 1959 Ind. P.
Nuts contain 1.5-2% caffein and traces of theobromine. Kola liquid extract (with alcohol) is used. Action is due to caffein content.	BPC. 1949. Other pharmacopoeias : Arg.,Aust. Belg.,Braz.,Chil.,Fr. Neth.,Pol., Port,Roum Spain, Swiss.
Formerly used as carminative but now mainly in flavour & fragrance industries; beta ionone ex. citral used for preparation of Vitamin A.; in soaps and detergents.	BPC. 1954. Braz., Ind.

8.	*Eucalyptus* spp.	Myrtaceae	Eucalyptus
9.	*Eugenia caryophyllata* Thunb. syn. *Syzygium aromaticum* (L) Merr.	Myrtaceae	Clove, Karafu

Species available in Zanzibar & Pemba are not properly identified. Two species on distillation did not give any significant quantity of oil	-
Cloves are carminative used in flatulence and dyspepsia. Infusions are sometimes used as basis for mixtures.	Pharmacopoeias of Aust., Braz. Fr., Hung., Ind., Jap., Neth., Port. & Swiss.
Clove oil is antispasmodic, carminative, occasionally used in the treatment of flatulent colic. Extrenally, it is irritant, rubefacient and slightly analgesic. It has been used in liniments with olive oil and is a house hold toothache remedy mixed with zinc oxide used as a temporary anodyne filling, though eugenol is often preferred. Also used as dentifrice, as a flavouring agent. It has also preservative properties. Clove oils (bud, stem, Leaf) are one of the most widely used essential oils in the world.	Pharmacopoeias of Arg., Aust., Braz., Chil., Chin. Fr. Ger., Hung., Indo, It., Mex., Neth., Port., Roum., Spn., Swiss and U.S.

10.	Garcinia indica Choisy.	Guttiferae	Kokum
11.	Hydnocarpus laurifolia (Dennst.)Sleumer	Flacourtiaceae	Chaulmoogra Oil
12.	Jatropha curcas Linn.	Euphorbiaceae	Physics nut
13.	Nicotiana tabacoum Linn.	Solanaceae	Tobacco
14.	Punica granatum Linn.	Punicaceae	Pomegranate
15.	Ricinus communis Linn.	Euphorbiaceae	Castor

Solid fat expressed from seeds used as suppository basis, used in ointments and other pharmaceutical purposes.	Indian Pharmacopoeia
Seeds and oil used in leprosy; ethyl esters of chaulmoogra oil are used, mostly replaced by the sulphones for leprosy treatment.	Pharmacopoiea of Neth., Port., Spain, Indi.,
Roasted nuts and seeds are purgative juice of plant useful in scabies eczema and ringworm; twigs are used for tooth brushing in swollen gums.	-
Leaves are sedative, narcotic, emetic, antiseptic, used in rheumatic swelling, skin diseases.	-
Dried bark of stem and root for expulsion of tapeworms; and as astringent, rind of fruit combined with aromatics like clove for diarrhoea and dysentry; pulp is cardiac and stomachic, fresh juice in cooking.	BPC. 1934. Pharmacopeia Jap., Port and Spain
Seed & seed oil purgative, oil is a soothing application to the conjuctavites and alloys irritation due to foreign body in the eye, used for making solution of alkoloids for ophthalmic purposes; used in making ointments.	All pharmacopoeias except France which describes the seed.

16.	Tamarindus indica Linn.	Leguminosae	Tamarind
17.	Taraktogenos kurzii king	Flacourtiaceae	Chaulmoogra
18.	Viola odorata Linn.	Violaceae	Violet

Fruit refrigerant, digestive, carminative, laxative, useful in disease caused by deranged bile; infusion employed as drink in febrile diseases. A polysaccharide (Tamarind polyose) extracted from the seed used as binding agent in tablets, as a suspending agent for insoluble powders and as an emulsifying agent. -

Fixed oil from fresh ripe seeds used as chaulmoogra oil; also produced from some species of Hydnocarpus. -

Plant antipyretic, diaphoretic, febrifuge; Flowers emollient, demulcent, used in biliousness and lung troubles, root emetic. -

WILD GROWING PLANTS

	Botanical Name	Family	Local/Common & Name
1.	Abutilon mauritianum	Malvaceae	Mbiha
2.	Adansonia digitata L.	Bombacaceae.	Mobale
3.	Aloe spp.	Liliaceae	Aloes, Mshubir Mwitu

Uses	Pharmacopoeia
Other species used medicinally in Africa (e.g. leaf for hiccup, roots as anthelmintic, plant as abortifacient, root applied locally in inflammation and abscess about the eye).	-
Pulp edible, makes refreshing and cooling dring with water used in fevers, haemoptysis and diarrhoea. In West Africa dried leaf, as condiment seasoning. Seed kernel used for flavouring soup. Fruit rich in Vitimin C. Fruits and seed in dysentry leaf is used as a prophylactic against fever (Malaria) to check excessive perspiration and as an astringent.	-
i, Aloes is an anthraquinone purgative Because of its griping tendency it is given in conjuction with belladonna and carminatives. Plant is atomachic purgative emmenagogue, anthelmintic and used in piles and rectal fissures; fresh juice is cathartic, cooling and useful in fevers; pulp in menstrual suppressions, root in colic.	Pharmacopoeias of Arg. Aust., Belg., Braz., Chil. Fr., Ger., Hung., Ind., It., Jap., Neth., Nord., Pol., Port., Roum., Span., Swiss & U.S.

4.	Aneilema siniçum	Commelinaceae	Kongwe
5.	Annona chrysophylla Boj.	Anonaceae	Mtopemtope
6.	Antiaris toxicaria (Pers.) Lesch.	Moraceae	Ngulele Upas tree
7.	Argemone mexicana Linn.	Papaveraceae	Mexican poppy
8.	Brexia madagascariensis	Saxifragaceae	Mjukukuku
9.	Barringtonia racemosa. Roxb.	Lecythidaceae	Mtomondo

Plant is used in colds.	-	-
Plant antidote in snake bite remedy in Tanzania, root as homicidal poison, bark as emetic and medicinally in Zanzibar, leaf as remedy in diarrhoea and abdominal heaviness, root with sodabicarbonate for veneral diseases, and root bark with soda bicarbonate for gastro intestinal complaints and infusion of leaf as an eye lotion. Fruit and leaf useful for guinea worm.		-
Sap is arrow poison, seeds are febrifuge and useful in dysentry.		-
Yellow juice and leaf used for the narcotic and anodyne properties for dressing wounds and application to warts, for jaundice and dropsy. Herb diuretic, seed narcotic, emetic, demulcent and expectorant and oil purgative. Root ia alternative and used in chronic skin diseases.		-
Root is used for yaws		-
The bark, seed and extract ofplant insecticidal, root and bark stomachic and for skin disease; fruit juice for eczema, stem and root bark rich source of tannin		-

10.	Bauhinia thonningii Schumach	Leguminosae	Mkumgo Mchekwa Dume, Camel foot
11.	Calophyllum inophyllum Linn.	Guttiferae	Mtondoo Alexandrian Laurel
12.	Cassia occidentalis Linn.	Leguminosae	Stinking weed, wild coffee, Kune Nyika
13.	Cassia tora Linn. syn. C. obtusifolia Linn.	Leguminosae	Kunde Nyika
14.	Cissampelos pariera Linn.	Menispermaceae	Kishiki cha buga

Bark gonorrhoea diarrhoea and dysentry remedy, leaf for chest complaints, cough remedy. Concentrated infusion in bark in inflammation of gums -

Oil from seeds specific for skin diseases and used in rheumatism. Bark is astrigent and used in internal haemorrhage, gum is emetic and purgative, juice is also purgative (Kernel has 50-70% oil). -

Leaf infusion to relieve abdominal pain leaf and stalk to get rid of body vermin, leaf decoction anthelmintic, poultice of leaf applied for relief of oedema, used as purgative and for fevers especially Malaria, for pleurisy as a prophylaic against leucorrhoea; plant as condiment and for perfuming. Roasted seed as a substitute for coffee; tincture of seed as febrifuge. -

Leaf decoction for eye trouble, as laxative, leaves and seeds in skin diseases, for ringworm and itch. -

extensively used as medicine in Africa. Roots used in pregnancy, as a sexual stimulant, for relief of abdominal pains, rheumatic pains and headache. Root infusion for snake bite. Root in treatment of blennorrhagia, haematuria and colic and as diuretic, as a purgative, antiperiodic, in dyspepsia and diarrhoea, for cough, as emmenagogue, and febrifuge, Externally leaf and root used for scabies, for abscesses and sores. -

15.	Coleus barbatus Benth.	Labiateae	Kaffir Potatoe
16.	Commelina benghalensis Linn. and C. zambesica	Commelinaceae	Kongwa
17.	Costus sarmentosus	Zingiberaceae	Mkatafingo
18.	Crinum kirkii Bak.	Amaryllidaceae	Nyonyore
19.	Datura fastuosa D. metel Linn.	Solanaceae	Mmaridia Mranaha
20.	Dissotis rotundifolia Triana	Melastomataceae	Pain killer, Kichinja uthia

As expectorant, emmenagogue and diuretic. It is, however, cultivated as a source of food.	-
Liquid within flowers for eye troubles, antidote for hot water ants, mucilage from the bud and calyx used as local application in thrush in infants, bruised leaf applied to burns. Plant used as demulcent, a refrigerant and laxative.	-
The stalk and juice of costus spp. is anthelmintic, which is sometimes used with the juice of Dissotis rotundifolia.	-
Fruit and inner part of the bulb as purgative. Outer sacles are poisonous and used as rat poison. Scales are soaked in water and used for washing sores in children.	-
Dried leaves used in medicine for the same purpose as belladona leaves. Flowers used in asthma; seeds, leaves and roots used in insanity, fever with catarrh.	Datura herb: Ind. P., BPC, 1949
Juice anthelmintic. It is tuberculosis remedy. Whole plant is used in rheumatism and yaws and as an anthelmintic as also for diarrhoea.	-

21.	Erythrophleum guineense G.Don.	Leguminosae	Ordeal tree, Mwavi, Mbaraka
22.	Euphorbia hirta L.	Euphorbiaceae	Milk weed Mziwaziwa, Quinsland Asthma plant
23.	Flagellaria guineensis Schum.	Flagellariacea	Mpepa
24.	Flueggea virosa Bail.	Euphorbiaceae	Mkwamba
25.	Gloriosa simplex L.	Liliaceae	Mkalamu, Mpewa, Msapare
26.	Harungana madagascariensis Poir.	Guttiferae	Ngoningoni, Mlamu mdamu.

Bark highly poisonous, weak maceration or a decoction used as an anthelmintic; powdered bark for headache; bark is emetic and purgative used also for rheumatisim, and skin diseases	-
Plant used in the form of liquid extract or tincture in the treatment of coughs and asthma	BPC 1954 Ind. PC
Berries used as a remedy for veneral diseases. Plant used for skin diseases and peristant leg ulcers. Leaf is astringent and used for making a hair wash.	-
Root infusion with meat broth for malaria Root and fruit as snake bite remedy, bark which contains tannin for diarrhoea and pneumonia.	-
Tubers abortifacient, Powdered root stock for treatment of impotency and barreness. Juice is considened disinfectant in the treatment of wounds.	-
Yellow 'latex' as dye and root and bark to many uses including developing female breasts and interupting menses. Exudate used for scabies and tapeworm. Bark is also tapeworm remedy. Leaf for haemorrhage, diarrhoea, gonorrhoea, sore throat and fevers. Resin from flowers used for colic puerperal infection, round worm and as rubefacient.	-

27.	Impatiens walleriana Hk f.	Balsaminaceae	Matuanange
28.	Ipomea pes-caprae SW.	Convolvulaceae	Majani ya mwaka, Mlakasa
29.	Lippia asperifolia A. Rich. syn: L. javanica Spreng.	Verbenaceae	Mpambake
30.	Melia azadarch	Meliaceae	Persian Lilac

Root as abortifacient, stems for abdominal and liver pains. -

Used externally for rheumatisim colic and dropsy. Ointment from leaf and extract of leaf give excellent results for bed sores. Boiled tuber is diuretic and brings relief in diseases of bladder, seed good remedy for stomachache and cramps. -

Weak infusion of leaf and stem for coughs, colds and bronchial troubles. Infusion made with addition of Artemisea afra and is then used for fever, influenza, measels and propylactic against lung inflammation. Smoke from burning the plant is sometimes inhaled for respiratory conditions . Plant finds varied uses in various parts of Africa. -

Plant used in other parts of Africa. Infusion of leaf and fruit as local appli ation of eczema. Aqueous extract of heartwood relieves asthmatic attacks. Plant as emetic and cathartic Strong decoction of root bark as an anthelmintic Plant as tonic and antipyretic. Ointment from pulp of fruit for skin diseases. Decoction of bark used as lotion on ulcers, including syphilitic ulcers and other skin diseases. A paste of leaf, flower, bark and root is effective as a local application to skin lesions of leprosy and scrofile . Aqueous leaf extract is insecticidal. A poultice of flowers is said to kill lice. Flower is used in treating eruption of scalp. Fruit oil considered to have same properties as neem (margosa)oil. -

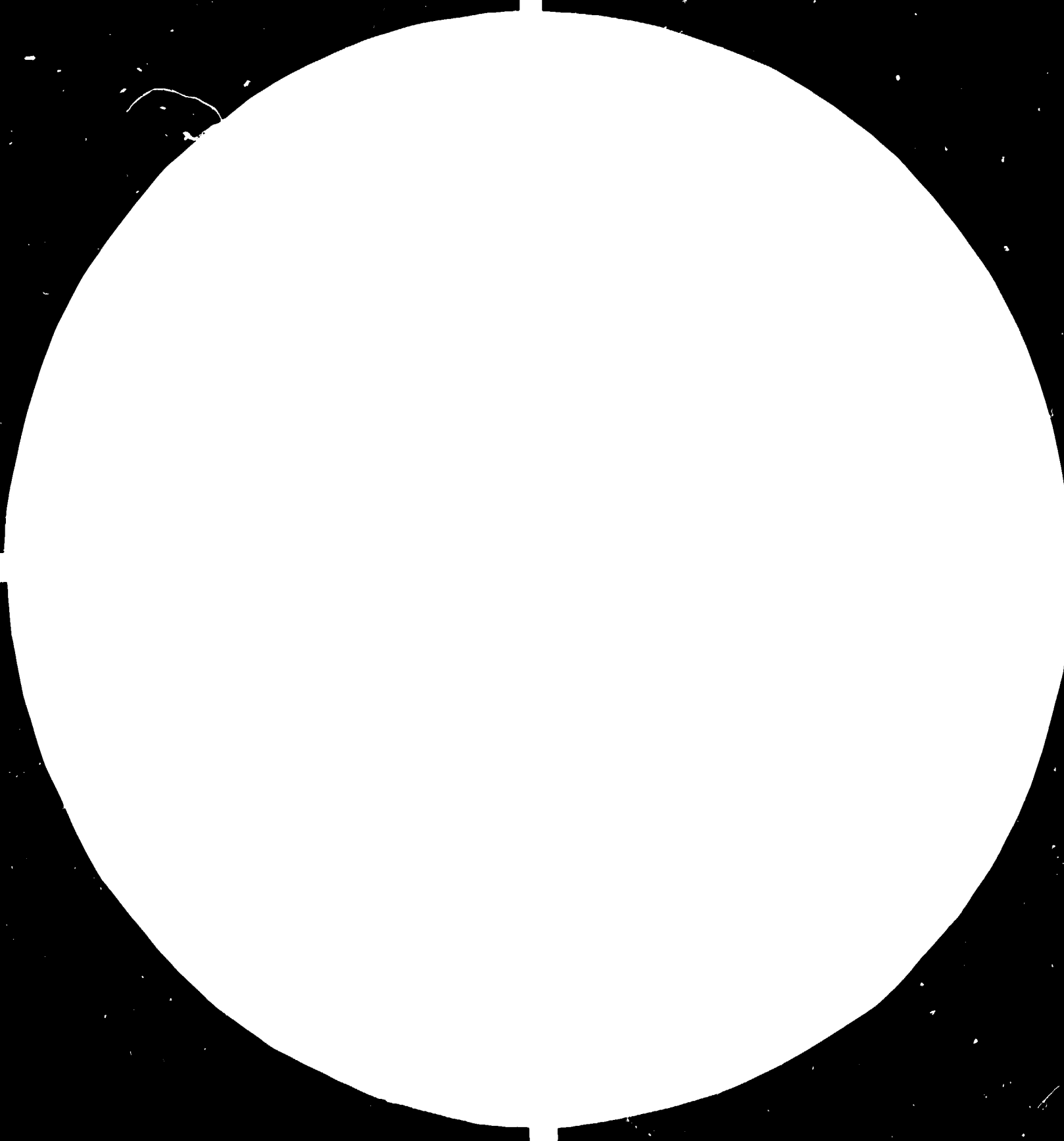
31.	Momordica charantia L.	Cucurbitaceae	Maidens blush, Mkasela
32.	Mucuna pruriens D.C. syn. M. prurita Hook.	Leguminosae	Buffaloe bean, Cow-itch, Mpupu
33.	Ocimum spp.	Labiatae	Mosquito bush Kivumbasi, Jembe la waganga, Vuo, Mtule.
34.	Ruellia tuberosa syn. Dipteracanthus tuberosa	Acanthaceae	-
35	Stachytarpheta jamaicensis (Linn.) Vahl. var. indica syn. S. indica Vahl.	Verbenaceae	Vervain
36.	Synadenium carinatum Boiss.	Euphorbiaceae	Mvunja kongwa
37.	Tanvolfia mombasiana Stapf.	Apocynaceae	-
38.	Thymus valgaris L.	Labiatae	Thyme
39.	Urena lobata Linn.	Malvaceae	Mtakata, Mchokochole Aramina fibre.

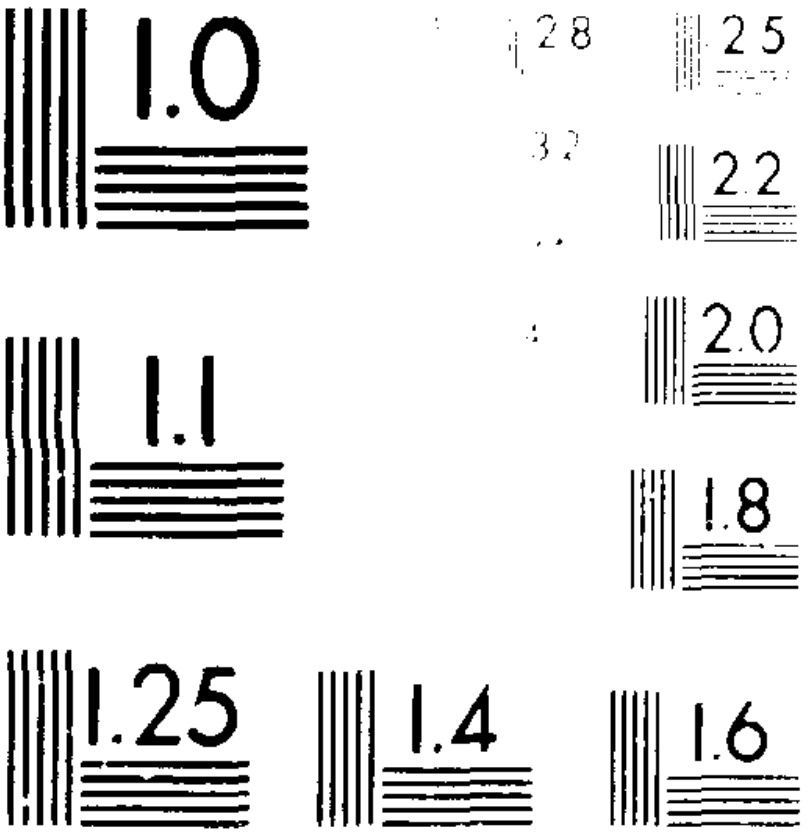
Fruit and leaves anthelmintic, useful in piles, leprosy, jaundice, vermifuge, seeds antidiabetic, juice of leaves, emetic, purgative, given in bilious affections, rubbed in burning of soles of feet.	-
Seeds nervous tonic, aphrodisiac in scorpion sting, pods anthelmintic, root purgative, in dropsy, stong infusion mixed with honey given in cholera (uses of the plant in Zanzibar are not available)	-
Infusion of leaf disinfectant and insceticide.	-
Infusion of tuberous roots cooling medicine.	-
Infusion of leaf cooling medicine used externally for purulent ulcers, given internally for fevers, and rheumatism, inflammation.	-
Milky juice used for treatment of boils.	-
Root used as homicidal agent and for killing dogs. An aqueous extract of the root has hypotensive effect and neutralises effect of adrenalin (Root has alkaloids among them 0.116 percent reserpine).	-
Found as garden plant and not used specifically.	-
Root decoction used for indigestion	-

MEDICINAL PLANTS: DENTIFRICE

	Botanical Name	Family	Local/Common Name	Uses	Pharmacopoeia
1.	Acacia farnesiana Wild	Leguminosae	Acacia, fragrant acacia	Young shoots used for cleaning teeth, bark astringent and demulcent; flowers give concrete and absolute used in fragrance industry.	-
2.	A. nilotica Del.	"	-	Greatly esteemed for tooth cleaning.	-
3.	Eugenia cumini Lam.	Myrtaceae	Mzambarau, Java Plum	Young shoots for cleaning of teeth, bark astringent used in the preparation of astringent decoctions, gargles and washes, fresh juice with goat's milk for children diarrhoea.	-
4.	Jatropa curcas Linn.	Euphorbiaceae	Physionut, Mbono, Microrura	Young branches as dentifrice; roasted nuts and seeds purgative, juice of plant useful in scabies, eczema and ringworm.	-
5.	Parinari curatellafolia Planch ex. Benth.	Rosaceae	Mbura	Strips of bark for tooth cleaning decoction of bark malaria remedy blood tonic and cardiac stimulant, (diseases of respiratory passages; (fruit edible).	-

B-535





FIXED OILS

	Fixed oil	Produced From	General Properties and uses	Products	Potential of Production and Utilization in Zanzibar
1.	Castor	From seeds of Ricinus communis Linn. (Euphorbiaceae)	Purgative, given in treatment of food poisoning; administered with milk or fruit juice, in capsules or emulsion; in conjuctivites to sooth eyes, and allays irritation due to foreign body in the eyes, making solution of alkaloids for ophthalmic purposes, in ointments.	i) Aromatic Castor Oil ii) Castor oil Emulsion iii) Castor oil Emulsion for infants iv) Castor Oil Enemas	Very good
2.	Chaulmoogra	From fresh ripe seeds of Hydnocarpus-wightiana Blume, H. anthelmintica. Pierre., H, heterophylla and other species; and from Taraktogens kurzii King (Flacourtiaceae)	For treatment of leprosy, skin diseases and certain cutaneous diseases. Usually used as ethyl esters of the oil.	i) Oil ii) Ethyl Ester of chaulmoogra oil	Good
3.	Margosa	From seeds of Azadirachta indica A. Juss. Syn. Melia azadirachta Linn. (Meliaceae)	Used in hair tonic and skin diseases, oil is stimulant, antiseptic, alternative in rheumatism	Oil	Good
4.	Theobroma	From roasted seeds of Theobroma cacao Linn. (Sterculiaceae)	Bases for suppositories, pressaries and bougies; as an ingredient of emollient cointments, also used as a lubricant in massage. Major ingredient of chocholates.	Oil (Cocoa butter)	-

MISCELLANEOUS:

	Botanical Name	Family	Local/Common Name	Uses	Pharmacopoeias
1.	Momordica foetida Schum. and Sond.	Cucurbitaceae	Mkarena	Fruit pulp poisonous to weevils, moths and ants; used as repellant	-
2.	Polypodium scolopendris	Filicineae	Koyiani, Mkutikuti.	Fern is reputed to be an absolute specific for bugs. Leaves when spread on bed repels bugs at once which do not come back for a long period	-
3.	Tacca involcarata syn. T. pinnatifida	Taccaceae	African, Tahiti or Fiji arrow root, Uwanga Jike	Root stock- bitter, full of starch when prepared is of excellent culinary properties, useful in dysentry. Rich source of starch (20-23 percent)	-
4.	Tephrosia vogelii	Leguminosae	Utupa wa kibaazi, utupa	African fish poison par excellence. Leaf, an efficient parasticide against flea; leaf and seed have same toxicity as of nicotine. Dry leaf retain toxicity properties even after a long time.	-

Annexure V

LIST OF APPARATUS & EQUIPMENT

Item	Quantity
Air leak tubes	5
Adaptor for rubber tubing NS 24/29	5
Adaptor receiver (Vacuum) NS 24/29	5
Evaporating dishes (15 ml. capacity)	3
Evaporating dishes (90 ml. capacity)	3
Evaporating dishes (320 ml. capacity)	3
Cylinders (10 ml. capacity)	5
Cylinders (25 ml. ")	5
Cassia flask 150 ml. capacity, flat bottom, thin neck grad. 0.1 ml glass with stopper.	3
Delivery adapter (Socket NS 24/29)	5
Multiple adapters (NS 24/29)	2
Splash heads (Anti foaming, NS 24/29)	2
Condensers Liebig (75 cm. NS 29/32)	5
Condensers Liebig, (40 cm. NS 24/29)	5
Condensers Allinn, (40 cm. NS 24/29)	2
Condensers Spiral (50 cm. NS 29/32)	2
Dropping funnels (250 ml. cap. NS 29/32)	4
Distilling link (NS 24/29)	4
Water jet pump (glass)	2

Water jet pump (nickel plated length 22 c.m.)	2	
Reaction bulb for high pressure	2	
Saponification, 500 ml. round bottom flask with air condenser 1m. in length.	5	
Distilling link with splash (NS 24/29)	3	
Claison heads (Different sizes)	5	
Distilling heads (NS 24/29)	5	
Still heads (NS 29/32)	3	
Still heads (NS 14/23)	2	
Reduction adaptors (Stocket 14/23) - (Cone 19/26)	2	
" " (" NS 14/23) - (" 24/29)	2	
" " (" 14/23) - (" 29/32)	2	
" " (" 19/26) - (" 24/29)	2	
" " (" 19/26) - (" 29/32)	2	
" " (" 19/26) - (" 34/35)	2	
" " (" NS 24/29) - (" NS 2932)	2	
" " (" NS 29/32) - (" NS 34/35)	2	
Ruber Cones	2	Sets
Expansion adaptors (Socket 19/26) - (Cone 14/23)	2	
" " (" 24/29) - (" 14/23)	2	
" " (" 24/29) - (" 19/26)	2	
" " (" 29/32) - (" 14/23)	2	
" " (" 29/32) - (" 19/26)	2	
" " (" 29/32) - (" 24/29)	2	
" " (" 34/35) - (" 19/26)	2	
" " (" 34/35) - (" 24/29)	2	

Spray guns (For T.L.C.)	4
Spray test tube	4
Separating chambers (Chromatank for plates (20 cm. x 20 cm.)	1
Separating chambers (Chromatank for plates (20 cm. x 5 cm.)	1
Separating chamber (round tank for plates (20 cm. x 10 cm.)	1
Separating chamber (29 x 17 x 28 cm.)	1
T.L.C. plates pre-coated (Assorted)	6 boxes
Chromatogram for paper	1
Chromatogram for paper	1
Chromojars (cylinders)	6
T.L.C. drying rack (for plates 20 x 20 cm,)	3
Stainless steel inset (for 2 plates up to (20 x 20 cm.)	3
Glass plates for T.L.C. (20 cm. x 20 cm.)	50
" " " " (20 cm. x 10 cm.)	50
" " " " (20 cm. x 5 cm.)	50
Chromatographic column 20 cm. x 1.5 cm.	5
" " 40 cm. x 2.0 cm.	5
" " 60 cm. x 3.0 cm.	5
" " 80 cm. x 4.0 cm	5
Reservoir for chromatographic column (250 ml)	5

Reservoir for chromatographic column (100 ml)	5
Reservoir for chromatographic column (2000 ml)	5
Cork stopper Assertment (bark)	2 x 4 kg.
Seperatory funnels (pear shaped, stop cock) (500ml capacity	5
Sepepratory funnel (as above 1000 ml)	5
Seperatory funnel (as above 2000 ml)	5
Cork bores	1 set
Fractionating column (length 360 mm 24/29)	2
" " (Length 600 mm NS 24/29)	2
Stoppers closed and assorted (from NS 14/29 - 34-35)	12
Thermometers (NS 14/23 0° to $250^{\circ}C$	5
Thermometers (NS 14/23 $10^{\circ}C$ - $110^{\circ}C$)	5
Thermometers (NS 14/23 $0^{\circ}C$ - $360^{\circ}C$)	5
Rubber tubing normal wall. (8 mm dia)	10 m
Rubber tubing " " (10 mm dia)	10 m
Rubber tubing " " (18 mm dia)	10 m
Rubber tubing " " (20 mm dia)	10 m
Rubber tubing " " (25 mm dia)	10 m
Rubber tubing Heavy wall (10 mm dia)	10 m
Rubber tubing " " (12.5 mm dia)	10 m
Filter papers Grade I (4.25 cm dia)	5 pkts of 1000 each
Filter papers Grade 1 Sheets, (46 x 57 cm)	5 boxes of 100 each
Sample bottles (50 ml capacity)	1 gross
" " (100 ml ")	- do -
" " (250 ml cap. stoper NS (24/29)	- do -

Sample bottles (500 ml cap stoppers NS 24/29)	10
Volumetric Pipettes (0.5 ml cap)	2
Volumetric Pipettes (1.0 ml cap.)	2
Volumetric " (2.0 ml cap.)	2
Volumetric " (3.0 ml ")	2
Volumetric " (5.0 ml ")	3
Volumetric " (10.0 ml ")	3
Volumetric " (20.0 ml ")	3
Volumetric pipettes (25.0 ml Cap)	3
Volumetric pipettes (50.0 ml cap)	2
Sand bath (dia 150 mm)	2
Sand bath (dia 200 mm)	2
Sand bath (dia 250 mm)	2
Burette (Capacity 10 ml. scale division 0.02 ml)	5
Burette (Capacity 25 ml. scale division 0.05 ml)	5
Burette (Capacity 50 ml. scale division 0.1 ml)	5
Weighing bottle with stopper (30 x 50 mm)	10
Tubing connector (Polyamidnylon for 3 mm tube or more)	10 pieces
Tubing connector (Polyamide-nylon for 5 mm tube " ")	10 pieces
Tubing connector (polypropolene Tfskape for 8-10 mm tube)	10 pieces
Tubing connector (Y, shape. polypropopene for 5 mm tube)	10 pieces.
Specffic Gravity bottle (10 ml capacity)	3

Pyknometer (1 ml. capacity)	3
Test tube (25 mm diam)	1 gross
Test tubes (12 mm diam)	1 gross
Test tubes (10 mm diam)	1 gross.
Glass tubes (Assorted diameters)	10 kg.
Glass rod (diam 4 mm length 1.5 m)	2 pkts of 30 each
Glass rod (diam 6 mm length 1.5 m)	2 pkts or 30 each
Capillary tubes	10 pkts
Thermometers for melting point	5
Graduated cylinders with spout (10 ml)	2
Graduated cylinders with spout (25 ml)	2
Graduated cylinders with spout (50 ml)	2
Graduated cylinders with spout (100 ml)	2
Graduated cylinders with spout (250 ml)	2
Graduated cylinders with stopper NS 19/27)	2
Round bottom flasks (cap 100 ml NS 24/29)	10
Round bottom flasks (cap 150 ml NS 25/29)	10
Erlenmeyer flasks (cap 250 ml NS 24/29)	10
Erlenmeyer flasks (cap 500 ml NS 24/29)	10
Round bottom flask (cap 100 ml NS 24/29)	10
Round bottom flask (cap 500 ml NS 24/29)	10
Flat bottom flask (cap 500 ml NS 24/29)	10
Flat bottom flask (cap 250 ml NS 24/29)	10

Conical flask (cap 1000 ml NS 24/29)	2
Conical flask (cap 500 ml NS 24/29)	2
Conical flask (cap 250 Ml NS 24/29)	2
Filtration flask (cap 1000 ml NS 24/29)	2
Filtration flask (Cap 500 ml NS 24/29)	2
Filtration flask (Cap 250 ml NS 24/29)	2
Buchner funnel (diam 60 mm cap 125 ml)	2
Buchner funnels (diam 4.25 cm)	2
Buchner funnels (diam 7.0 cm)	2
Buchner funnels (diam 11.0 cm.)	2
Filter flask (cap 250 ml)	2
Filter flask (cap 500 ml)	2
Heating elements (spiral 180 mm diam IKW)	2
Heating element for water bath	2
Water bath (6 holes with concentric rings)	2
Heating and drying oven	1
Melting point apparatus	1
Spare lamp for M.P.	2
Spare heater for M.P.	2
Balance spring	1
Balance, double pan	1
Balance box (weight 200 g x 0.1 mg)	1
Hot plate (spiral 180 mm dia 1 to 2 K.W.)	1

Hot plate (spiral double ring 140 mm dia 2. KW)	1
Heating element (spiral 140 mm dia 1 K.W.)	1
Liquid solid extractor (Soxlet complete unit 2000 ml)	2
Rectification column (Cap. 20 litre flask with heating mantle)	1
U.V. lamp	1
U.V. tube (6 watts, long wave)	4
U.V. tube (6 watts, short wave)	4
U.V. lamp protecting goggles	2
Heating mantle (multisize, 50-500 ml cap flasks)	1
Heating mantle (multisize, 500-1000 ml cap. flasks)	1
Spare heating (elements for) mantle (for 50-500ml flask)	2
Spare heating (elements) mantles (for 500-1000ml flask)	2
Refractometer (Abbes.)	1
Polarimeter with sodium lamp	1
Polarimeter tube (20 cm length)	2
Polarimeter tube (10 cm length)	2
Polarimeter tube (20 cm length 2 ml cap)	2
Polarimeter tube (20 cm length 1 ml cap)	2
Transformer for Polarimeter	1
Circular disc. (cover glasses)	10
Grinder (mixer)	1
Retort stand (120 cm length)	5

Retort stand (170 mm length)	5
Retort stand Rods (500 mm length)	4
Retort stand Rods (600 mm length)	4
Retort stands rods (750 mm length)	4
Retort stand rods (1000 mm length)	4
Retort stand Clamps	10
Retort stands Boss heads	10
Retort stands Rings (diam 35 mm)	4
Retort stand rings (diam 10 mm)	4
Retort stand rings (diam 75 mm)	4
Retort stand rings (diam 1000 mm)	4
Stirrer (Electric)	1
Plant Press	1

CHEMICALS & SOLVENTS .

Chemical	Quantity	Quality
Acetone	25 lit.	AR
Ammonia liquor	1x2.5 lit.	LR
Acetic anhydride	5x500 ml.	AR
Anilin	2 x 500 ml.	AR
Benzene	10 x 1 lit.	AR
Camphor	1 x 100 g.	MAR
Carbon disulphide	1 x 1 lit.	AR
Ortho - Cresole	1 x 500 ml.	AR
Citric acid	1 x 500 gm.	LR
Acetic acid glacial	3 x 1000 ml	LR
1,2 Dichloro ethane	20 x 500 ml	LR
1,3 Dinitro benzene	1 x 25 gm	LR
Diethyl ether	50 x 500 ml.	-
2,4 Dinitrophenyl hydrazine	1,x100 gm	LR
Ethyl acetate	1x25 lit.	AR
Formic acid (100 %)	1 x 500 ml.	AR
Bromophenol blue	2 x 5 gm.	LR
Conc. Hydrochloric acid	4x 2.5 lit.	LR
Methanol	4 x 500 ml.	AR
Potassium hydroxide (Pellets)	4 x 500 gm.	LR
Potassium iodide	1 x 100 gm.	LR
Potassium dichromate	1x 500 gm.	LR

Phenolphthalein	2x25 gm.	LR
Petroleum ether (40° - 60°)	5 x 2.5 lit	LR
Petroleum ether (60°- 80°)	5x 2.5 lit.	LR
Petroleum ether (80°- 100°)	5x 2.5 lit	LR
Magnesium Sulphate	5x500 gm.	LR
Sodium acetate	5x500 gm.	LR
Sodium hydroxide (pellets)	10x500 gm.	LR
Sodium sulphate	3x 1000 gm.	LR
Sodium bisulphite	4x500 gm.	LR
Salicylic acid	1x250 gm.	LR
Sodium bicarbonate	1x1000 gm.	LR
Sodium sulphite	10x500 gm.	LR
Sulphuric acid (Conc.)	4x2.5 lit.	LR
Sodium thiosulphate	1x500 gm.	LR
Sodium nitrite	1x500 gm.	LR
Silica gel G.F. (T.L.C.)	5x 500 gm.	-
Silica gel T.L.C.	10x500 gm.	-
Silica gel (Column)	4x500 gm.	-
Silver nitrate	4x25 gm.	AR
Semicarbazide hydrochloride	1x100 gm.	LR
Pyridin	2x500 ml.	AR
Phthalic anhydride	1x500 gm.	AR
Tartaric acid	1x500 gm.	LR
Oxalic acid	1x500 gm.	AR
Ferrous sulphate	1x500 gm.	LR
Vanillin	1x 100 gm.	AR
Thymol phthalein	2x5 gm.	LR
Adhesive Araldite	large size	-

Annexure VI

LIST OF MATERIAL REQUESTED FOR WORK

(MIN. OF AGRICULTURE) 26 DECEMBER 1983.

ORODHA ZA SAMPULI ZILAZOHITAJIKA

1.	Small cardamon, both Malabar & Mysore varieties. (Splits and separated seeds if available, may be supplied).	1Kg. each (dry)
2.	Mace	1kg.
3.	Nutmeg	up to 5 kg.
4.	Lemon grass at 8 weeks interval to see seasonal yield & quality	30 kg.
5.	Black pepper	1 kg.
6.	Ginger	1 kg.
7.	Orange peels	5 kg.
8.	Bitter orange leaves	5-10kg.
9.	Camphor tree leaves	10 kg.
10.	Cananga flowers	10 kg.
11.	Cinnamon (True)	
	Leaves	10 kg.
	Bark	1 kg.
12.	Pimento leaves (collected from under the trees)	10 - 20 kg.
13.	Pimento berries	1 - 2 kg.
14.	Vanilla pods (cured)	1 - 2 kg.
15.	Vetiver roots	10 - 20 kg.
16.	Tacca tubers (for starch)	20 kg.

Government Chemical Laboratory, Ministry of Agriculture, Z'bar

The laboratory is charged with the task of soil analysis with a view to advising the farmers about the level of soil fertility and the requirement of fertilisers. Work was also being done in the past on the evaluation of some essential oils from aromatic plants of the area.

Clove buds have been distilled in a small laboratory unit, made of copper, with the facility of cohobation of the distillate. The charge consists of 100 gm of clove buds (whole) mixed with 500 cc of water. Complete distillation takes about 24 hours, yielding a pale yellow, heavier than water oil in an yield of 16 per cent; a maximum of 16.5 per cent oil has been obtained.

With the help of ZSTC distillery, ylang-ylang flowers were distilled. No data was available on its oil content. Distillation was done in two steps; oil collected during first 3 hours and thereafter during next 12 hours. A bulk sample of about 1.5 kg oil was available.

Oil of nutmeg was produced in the laboratory. No further data was available.

Lime oil was also produced. No data was available. None of the above mentioned oil samples were analysed for their physico-chemical properties.

No work is being done on the essential oil-bearing plants now.

Annexure VIII

Quality Control and Analytical Laboratory, Pharmaceutical Plant, Ministry of Health - Zanzibar.

Pharmaceutical Plant has its own Quality Control Laboratory to analyse and check quality of tablets, saline and Dextrose solutions, vitamins, antibiotics, pyrogen-free water, etc. The laboratory is manned by 6 technically qualified persons.

The laboratory has equipment like oven, autoclave, deep freeze, muffle furnance, flourimeter, disintegration and hardness tester, sieves, chemical balances, and saccharimeter. Normal glassware, chemicals and few solvents are also available.

One room is air conditioned which houses U.V. spectrophotometer, a pH meter, centrifuge, Ultra-X for moisture determination.

However, laboratory is not equipped with respect to work on essential oils. Apparatus, equipment and chemicals needed in this work are listed in Annexure V .

Annexure IX

Cloves- Grade Specifications:

The Government of Zanzibar specifies 4 grade for cloves which are applicable not only at the stage of purchasing from the growers and producers but also at the export consignment certification. The International Standards Organisation has also laid down specifications for cloves (ISO 2254 - 1980) which are identical with the standards laid down by the British Standards Institution (BS 6097 - 1981). Specifications on cloves are under:-

Zanzibar/ISO. Clove Grades

	Grade:	Standard:	Moisture Content	Headless Cloves:	Tendrils of Mother Cloves:	Extraneous matter:	Khokar cloves
I.	Special Quality	Zanzibar	14	←	2	→	
		ISO	12	2	2.5	0.5	0.5
II.	Standard Quality	Zanzibar	14	←	4	→	
		ISO	12	5	4	1	3
III.		Zanzibar	-	Not specified	-	-	-
		ISO	12		6	1	5

(Figure given about are "Percentage- Maximum"

Bulk of the crop of cloves in Zanzibar falls within Grade II i.e. Standard Quality.

The Fourth Zanzibar grade is the "Distillation Quality" which allows for up to 20 percent content of 'khokar' cloves.

Annexure X

ESSENTIAL OILS and AROMATIC CARMINATIVES

Essential oils known as ethereal or volatile oils are still used in various forms for medicinal purposes even though their use has decreased with the advancement in the pharmaceutical industry. Essential oils when taken internally exert a mild irritant action on the mucous membranes of the mouth and the digestive tract which induces a feeling of warmth and increase salivation, during excretion by the bronchioles they act as mild expectorants. Taken after meals they are carminative and are, therefore, employed for the relief of gastric discomfort and of flatulent colic and also to counteract action of purgatives. On the skin, they produce irritant and rubefacient action causing first a sensation of warmth and smarting, followed by mild local anaesthesia. For this reason they are used as counter irritant and cutaneous stimulants in the treatment of chronic inflammatory conditions and to relieve neuralgia and rheumatic pains. However, they may also cause sensitisation. When inhaled they render secretion more fluid and relieve congestion of bronchioles and they may be employed for this purpose in conditions such as chronic bronchitis.

Essential oils are also employed as flavouring agents in medicinal preparations. Besides flavouring action, essential oils act as carminatives.

Information on uses of essential oils, their products and other aspects are given on the following pages of Annexure X.

LIST OF IMPORTANT ESSENTIAL

	Essential Oil	Produced from and oil content	General Properties and use (s)
1.	Achilla	Dried flowering tops of Achillea millefolium (Compositae) 0.25 percent.	Variety of medicinal purposes. Diaphoretic, stimulant and haemostatic properties.
2.	Ajowan	Dried ripe fruits of Trachyspermum ammi syn. Carum copticum. (Umbelliferae) 4 to 6 percent.	Aromatic carminative; commercial source of thymol (fruit caminative and antispasmodic).
3.	Allspice	See under Pimento	
4.	Amber	Destructive distillation of certain resins or by distilling resin oil.	Properties similar to turpentine oil
5.	Amyris	Wood of Amyris balsamiferae (Rutaceae)	Uses as of those of sandalwood oil
6.	Anise	Dried ripe fruits of Pimpinella anisum (Umbelliferae) 2 percent and above and dried ripe fruit of Illcium verum (Magnoliaceae) 5 percent and above	An aromatic caminative, expectorant and flavouring agents; ingredient of cough mixtures and lozenges. (Anise fruit is carminative and mildly expectorant and used for producing oil).

OIL IN TRADE

Products	Potential of Production and utilisation in Zanzibar
Infusion and liquid extract.	-
Aromatic water	Good; may be cultivated
	-
Liniments	-
Essential oil	-
i) Aqua Anise ii) Syrupus Anise iii) Anise Emulsion iv) Anise Spirit v) Anise Water vi) Concentrated Anise Water	Good_recommended for cultivation

6.	Anethi	See under Dill	-	-	-
7.	Amomum	Oil not produced; Fruits of *Amomum amarum*, *A. aromaticum* and *A. subulatum* (Zingiberaceae).	Used as a substitute for true cardamom.	-	Good -
8.	Bay	Leaves of *Pimentochris* syn. *P. racemosa* (Miller) (Myrtaceae) J.W. Moore	Used as hair lotion, as an astringent application to the face after shaving.	Bay Rum	Good - may be cultivated
9.	Bergamot	Fresh peel of fruit from *Citrus bergamia* (Rutaceae)	Perfumery	Preparations for hair	-
10.	Betel	Dry leaves of *Piper betel* (Piperaceae) Oil not produced.	Stimulant and carminative properties.	Masticatory; chewing of leaves.	-
11.	Bitter Almond	Distillation with water of cake left after removing of fixed oil by expression of kernels from bitter almond, peach or apricot.	Flavouring agent	Emulsions and for culinary purposes.	-
12.	Cade	Cade oil is obtained by destructive distillation of branches and wood of *Juniperus oxycedra* (Cupressaceae). Essential oil not produced.	Treatment of psoriosis and eczema, and seborrhoea	Ointments, Shampoo and Medicated soap.	-

13.	Cajeput	Fresh leaves and twigs of species of Melaleuca e.g. M. cajuputi and M.leucadendron Linn. (Myrtaceae)	Internally as carminative and externally as a stimulant and mild rubefacient in rheumatism.	Ointments and Liniments	Good
14.	Capsicum	Oleo resin produced from dry ripe fruit of Capsicum annuum var. minimum and C. frutescens (Solanaceae)	Carminative, in atonic dyspepsia, externally as counter-irritant in lumbago, neuralgia and rheumatism.	i) Strong Capsicum Tincture. ii) Capsicum Cotton Wool. iii) Self Adhesive Plaster. iv) Gauze and Capsicum Tissue. v) Capsicum Ointment. vi) Compound Capsicum Ointment. vii) Capsicum Tincture	Good
15.	Calamus	Dried rhizomes of Sweet Flag; Acorous calamus (Araceae) 1.5 to 3.5 percent.	A bitter and carminative	Infusion	-
16.	Caraway	Oil from freshly ground fruits. Dry ripe fruits of Carum carvi (Umbelliferae) 3.5 percent and above	Aromatic carminative; for flatulent colic of infants.	i) Caraway water ii) Concentrated caraway water	Good, recommended for cultivation.
17.	Cardamom	Seeds of dry, nearly ripe fruit of Elettaria cardamomum var. minuscula (Zingiberaceae) 4 per cent and above.	Carminative; as flavouring agent.	i) Compound Cardamom Tincture. ii) Aromatic Cardamom Tincture.	Very good
18.	Cassia	From the leaves and twigs of Cinnamomum cassia (Lauraceae) 1 percent & above	Carminative and slightly astringent.	Powdered drug from the bark.	-
19.	Cedarwood	Wood of Juniperus virginiana and other species of red cedar (Cupressaceae).	Perfumery; cleaning agent in microscopy.	Essential oil	-

20.	Celery	Dry ripe crushed fruits of *Apium graveolens*. (Umbelliferae) 1.5 percent and above.
21.	Chamomile	Dried flower heads of *Anthemis nobilis*. (Compositae)
22.	Chenopodium (American wormseed)	From fresh flowering and fruiting plant of *Chenopodium ambrosioides* var. *anthelminticum*. (Chenopodiaceae).
23.	Cinnamon	Bark oil from the inner dried bark and leaf oil from leaves of *Cinnamomum zeylanicum*. (Lauraceae) 1 percent and above in bark.
24.	Citronella	From leaves of *Cymbopogon nardus* and *C.winterianus* (Graminaceae)
25.	Clove	Bud, stem and leaf oil from the dried flower buds, stem and leaves respectively of *Eugenia caryophyllus* syn. *Caryophyllus aromatica* syn. *Eugenia aromatica*. (Myrtaceae) Oil from: buds 12 to 20 percent stems 4 to 6 " leaves 2 to 5 "

Antispasmodic; celery fruit as a household remedy for rheumatism. Flavouring agent.	Essential oil	-
Aromatic carminative and flavouring agent. (Chamomile flower is aromatic bitter, emetic).	i) Infusion 'Chamomile Tea' household remedy for indigestion. ii) Poultice for inflammation. iii) Hair Preparation.	-
Anthelmintic, particularly for round worms (Ascaris) hookworms, dwarf tapeworms.	Essential oil.	-
Bark and bark oil are carminative, used as flavouring agent, as inhalation, spray, occasionally as preservative.	i) Cinnamom Tincture ii) Distilled Cinnamon Water iii) Syrupus Cinnamoni iv) Cinnamon Spirit v) Concentrated Cinnamon Water	Good
Flavour and fragrance, soap and cosmetic industry, mosquito-repellant.	i) Antimosquito preparations ii) Aqua Citronellae iii) Spiritus Citronellae	Good, recommended for cultivation on large scale.
Carminative and antispasmodic, externally irritant, rubefacient and slightly analgesic. Oil is household remedy for tooth-ache. Flavour & fragrance industry	i) Clove water ii) Concentrated clove Infusion. iii) Anodyne Dental Filling iv) Tooth-ache Drops v) Powdered Clove.	Excellent

26.	Copaiba	From copaiba (oleoresin) obtained from the trunk of *Copaifera langsdorfi* and other species of Copaifera. (Leguminosae)	Carminative, used as urinary antiseptic in chronic cystitis and gonorrhoeal urethritis.	Oleoresin and Essential Oil	-
27.	Coriander	Dry ripe or nearly ripe fruits of *Coriandrum sativum*. (Umbelliferae) 0.3 percent and above	Aromatic stimulant and carminative.	i) Powdered drug ii) Essential Oil	Good-recommended for cultivation.
28.	Cubeb	Dry, unripe, fully grown fruit of *Piper cubeb*. (Piperaceae). 15 percent and above.	Urinary antiseptic. It was used earlier but not now. Flavouring agent.	Essential Oil	-
29.	Dill. (Anethi)	Dried ripe fruits of *Anethum graveolens* (European dill) and *A.sowa* (Indian dill) (Umbelliferae). 2.5 percent and above	Aromatic carminative, especially for flatulence in infants.	1) Concentrated Dill water. ii) Dill water iii) Gripe Mixtures.	Good-recommended for cultivation.
30.	Elemi	Oleoresin exuded through the bark of *Canarium luzonicum*. (Burseraceae).	Properties similar to those of turpentine, local stimulant.	Ointments.	-
31.	Eucalyptus	From the leaves and terminal branches of some species of Eucalyptus giving oil rich in Cineol such as *E. globulous*. (Myrtaceae)	For catarrhal conditions of respiratory tract, for cough in chronic bronchitis and asthma.	i) Pastilles ii) Balms iii) Inhalers iv) Oil spray solutions. v) Ointments and Liniments.	Existing plants species need screening.
32.	Fennel	Dried fruit of cultivated plants of *Foeniculum vulgare* var. *vulgare* syn. *F. capillaceum*; *F.dulce*; (Umbelliferae) 1.2 percent and above.	Aromatic carminative; for treatment of flatulence.	i) Concentrated Fennel water. ii) Fennel water	Good-recommended for cultivation

33.	Galanga	Dry rhizome of Alpinia officinarum (lesser galanga) and A. galanga (greater galanga) (Zingiberaceae) 0.5 to 1.5 percent	Aromatic carminative, similar in effect to ginger, in rheumatism and catarrhal affections.	Infusion or Decoction.	-
34.	Geranium	Over ground part of plants of Pelargonium Spp. (Geraniaceae)	Fragrance and Cosmetic Industry.	Essential Oil	-
35.	Ginger	Distillation of rhizomes for oil and extraction with solvent for Oleoresin - of Zingiber officinale. (Zingiberaceae)	Carminative properties, sometimes added to purgatives to prevent griping; Flavour industry.	1) Oleo-resin ii) Ginger syrup iii) Mist. Zingib. c. Rheo. iv) Strong Ginger Tincture v) Weak Ginger Tincture.	Good
36.	Juniper	Dried ripe fruits of Juniperus communis (Cupressaceae). 0.5 to 2 percent.	Carminative, used in flatulence and colic; diuretic.	i) Juniper Spirit ii) Oleum Juniperic Lign.	-
37.	Laurel	Dry ripe berries of Laurus nobilis (Lauraceae) 1 percent or above	Flavouring Industry. (Berries were reputed to have carminative, emmenagogue and diuretic properties).	Essential Oil	-
38.	Lavandin	Over ground part of hybrid of Lavandula latifolia & L. officinalis. (Labiatae).	Soap & Fragrance Industry.	Essential Oil	-
39.	**Lavender**	Fresh flowering tops of Lavandula intermedia and L. officinalis syn. L. angustifolia.	Carminative, used in flatulence and colic, insect repellent. Fragrance industry, sometimes used in Pharmaceutical industry to cover disagreeable odours; Preservative properties.	i) Compound Lavender Tincture. ii) Lavender Spirit.	-

40.	Spike lavender	Over ground part of *Lavandula latifolia*.	Fragrance Industry	Essential Oil	-
41.	Lemon grass	Aerial part of the plant *Cymbopogon flexuosus* and *C. citratus*. (Gramineae).	As carminative in past; Flavour and Fragrance Industry; for production of vitamin A.	Essential Oil, perfumery isolates and chemicals, Vitamin A.	Good-recommended for large scale cultivation.
42.	Lemon	Expression of fresh lemon peel of *Citrus limon* (Rutaceae).	Carminative; mostly used in Flavour Industry.	i) Lemon Oil ii) Terpeneless Lemon Oil iii) Lemon Spirit iv) Lemon Syrup v) Natural Lemon Syrup vi) Lemon Tincture and Syrup from dry lemon peels.	Good
43.	Mace	Arillode of seed of *Myristica fragrans*. (Myristicaceae). 7 to 14 percent.	Aromatic carminative Flavour Industry	Essential Oil	Good
44.	Matricaria	Dry flowerheads of *Matricaria chamomilla*. (Compositae). 0.4 percent and above	Same use as that of Chamomilla.	i) Powdered Matricaria ii) Essential Oil	-
45.	Melaleuca	Leaves of *Melaleuca alternifolia*. (Myrtaceae)	Constitnent of disinfectants.	Essential Oil	-
46.	Melissa	Leaves and tops of *Melissa officinalis*. (Labiatae).	Sedative & nervous tonic; carminative and diaphoretic; digestive stimulent & as a fragrant stimulating application to the skin.	i) Ingredient of Aromatic Spirits and Aromatic waters. ii) Compound Aromatic Spirit.	-

47.	Mustard (Black & White)	Ripe seeds of Brassica nigra (Black mustard) and B.alba (White mustard) (Cruciferae).	Condiment, emetic, counter irritant.	i)Mustard Bath (from seeds) ii) Mustard Liniment iii) Spiritis Sinapsis	-
48.	Neroli	Flowers of bitter orange tree, Citrus aurantium. (Rutaceae)	Flavour & Fragrance Industry	i) Concentrated Orange Flower Water. ii) Elixir Aromaticum iii) Orange-flower Water.	-
49.	Niaouli	Fresh leaves of Melaleuca viridiflora. (Myrtaceae).	Used in rhinitis, laryngitis and diseases of respiratory tract.	i) Syrupus Olei-Aetheri Niaouli	-
50	Nutmeg	Dry kernels of seeds of Myristica fragrans (Myristicaceae). 5 percent and above.	Aromatic and carminative, mildly rubefacient.	i) Liniments and Hair Lotions. (Expressed Nutmeg Oil incorporated in plasters and hair lotions).	Good
51(i)	Orange	From fresh peels of Citrus sinensis of distillation of dry orange peels (Rutaceae).	Flavour and Fragrance Industry	i)Aromatic Elixir ii)Compound Orange Spirit iii)Sweet Orange Peel Tincture.	Good
(ii)	Bitter Orange	Peels of Citrus aurantium (bitter orange)	Dry bitter orange peels are carminative	i) Simple Elixir ii) Orange Liquid Extract iii) Concentrated compound orange Peel Infusion. iv) Concentrated Orange Peel Infusion	Good

52.	Origanum	Fresh or dry flowering tops of Marjoram, Origanum marjoranna and O.vulgare. (Labiatae).
53.	Orris	Peeled and dry rhizomes of Iris germanica, I.pallida and I. florentina. (Iradaceae).
54.	Plamarosa	Leaves and flowering tops of Cymbopogon martini var. motia (Gramineae).
55.	Parsley	From dry fruits of Petroselinum crispum syn. P.sativum; Apium petroselinum. (Umbelliferae).
56.	Pepper	Dry unripe fruit of Piper nigrum. (Piperaceae). 1 to 2.5 percent.
57.	Peppermint	Whole fresh flowering overground part of Mentha piperita. (Labiatae)

	v) Aromatic Syrup vi) Orange Syrup vii) Bitter Tincture viii) Orange Tincture	
Herb is an aromatic carminative; used in cough syrups; used externally in healing lotions with other herbs.	-	-
Fragrance and cosmetic Industry	i) Orris Tincture ii) Syrup of Violets	-
Flavour and Fragrance Industry	Essential Oil and Isolates	-
Fruit & root diuretic and emmenagogue. Oil in Flavour Industry.	Liquid Extract of Fruit and Root.	-
Fruit is diaphoretic and diuretic; stimulates taste buds increasing gastric secretion. Oil as Flavouring agent	Essential Oil and Oleo-resin	Good
Aromatic carminative, relieves gastric and intestinal flatulence and colic; used with purgatives to prevent griping; flavouring dental preparations	i) Concentrated Peppermint Emulsion. ii) Concentrated Peppermint water. iii) Diluendum Methae. iv) Peppermint Spirit. v) Peppermint water.	Good-recommended for trial cultivation.

58.	Pimento	Dry full grown unripe fruit of Pimenta officinalis. (Myrtaceae) 3 to 4.5 percent.
59.	Pine	From wood of Pinus palustris and other species of Pinus by extraction and fractionation or distillation of wood. (Pinaceae).
60	Pulegium	Fresh herb of Mentha pulegium. (Labiatae)
61.	Pumilio Pine	From the fresh needles of Pinus mugo var. pumilio. (Pinaceae).
62.	Rose	Fresh flowers of Rosa damascena. (Rosaceae).
63.	Rosemary	Flowering tops and leaves with twigs of Rosmarinus officinalis. (Labiatae).
64.	Rue	Dry herb of Ruta graveolens. (Rutaceae)

Carminative and Flavouring agent.	Essential Oil	Good
In general disinfectants and deodorising purposes.	i) Pine Oil Inhalations	-
Emmenagogue	i) Essential Oil ii) Spirit	-
Externally as rubefacient in sprains and fibrositis; relieves cough and nasal congestion when inhaled with steam.	i) Essential Oil as inhalant in conjunction with other ingredients.	-
Fragrance Industry; Toilet preparations, lozenges, dentifrice and ointments.	i) Concentrated Rose water ii) Rose water iii) Rose water ointment	-
Carminative and mildly irritant; used in hair lotions, soap, liniments.	i) Essential Oil ii) Rosemary Spirit	-
Antispasmodic and emmenagogue; powerful local irritant.	Essential Oil	-

65.	Sage	Dry leaves of Salvia officinalis. (Labiatae)
66.	Sandalwood	Heartwood and root of Santalum album. (Santalaceae)
67.	Sassafras	Root or root bark of Sassafras albidum. (Lauraceae). 3 percent and above
68.	Savin	Fresh or dry young shoots of Juniperus sabina. (Cupressaceae). 1. to 4 percent.
69.	Spearmint	Fresh flowering overground part of Mentha spicata syn. M. viridis. (Labiatae).
70.	Sweet Birch	From Betula lenta (Betulaceae).
71.	Terebene	Steam distilled product of sulphuric acid treated turpentine Oil
72.	Thyme	Leaves and flowering tops of Thymus vulgaris and other species of Thymus and Origanum. (Labiatae). 1 percent and above.

Carminative; spasmolytic properties and diminishes salivation, flavouring agent.	Essential Oil	-
Fragrance industry; previously used with cubeb as a urinary antiseptic.	Essential Oil	-
Rubefacient, flavouring agent.	Essential Oil	-
Emmenagogue	Essential Oil	-
Carminative and flavouring agent. Used similar to oil of Peppermint.	i) Concentrated spearmint water ii) Spearmint water	Recommended for trial cultivation
Relief of lumbago, sciatica and rheumatic conditions	i) Liniments ii) Ointments	-
Rubefacient, used for rheumatic pains and stiffness odour more agreeable than turpentine oil	i) Pastilles	-
Herb is carminative, used as an ingredient of cough linctuses; as flavouring agent. Oil is antimicrobial, antispasmodic and carminative, used for whooping cough and bronchitis; rubefacient and counter-irritant.	Essential Oil	-

LIST OF AROMATIC CARMINATIVES

	Compound	Description	Properties	Preparations	Scope of Production in Zanzibar
1.	Anethole	White pale yellow crystalline compound, obtained from natural sources e.g. Oil Anise, Fennel or synthetically.	Aromatic carminative, expectorant and flavouring agent; common ingredient of cough mixtures and lozenges	-	Good if cultivated
2.	Apiol	Green coloured oily liquid obtained from Parsley by alcoholic extraction	Emmenagogne but of doubtful therapeutic value	-	-
3.	Benzaldehyde	Clear colourless liquid having adour of bitter almonds	Flavouring agent in place of bitter almond oil.	i) Syrup containing 0.2 percent benzaldehyde used in place of Wild Cherry syrup. ii) Benzaldehyde spirit. iii) Compound Benzaldehyde Elixir.	-
4.	Camphor	Natural camphor from the wood of Cinnamomum camphora (Lauraceae) and synthetic	Internally irritant and carminative; mild expectorant, relieves griping. Externally, rubifacient, mild analgesic, employed in liniments as a counter-irritant in fibrositis, neuralgia and similar conditions. Subcutaneous or intra-muscular injection as a circulatory and respiratory stimulant.	i) Camphor Injections ii) Compound Linctus iii) Camphor Liniment iv) Camphor Compound Mixture v) Camphor Ointment	Good

				vi) Hard Camphor Ointment vii) Camphor Spirit viii) Compound Camphor Spirit ix) Camphor Water X) Compound Camphor water	
5.	Cineol, 1:8	From Eucalyptus oils rich in cineol, cajuput oil and other oils.	Action and uses as those of Eucalyptus oils but less irritating to mucous membranes. Used with other counter irritants in ointments; antimicrobial properties, used in dentifrices Ingredient of many pharmaceutical preparations.	i) Inhalants ii) Ointments	Cineol rich oil is yet to be produced.
6.	Eugenol	From clove oil	Properties similar to clove oils i.e. antispasmodic and carminative; sometime used in flatulent colic. Externally irritant rubefacient and slightly analgesic. Used in liniments. Employed in dentistry as flavouring agent and mild rubefacient, as an oletudent for hypertensive dentine, caries or exposed pulp, mixed with zinc oxide, as a temporary anodyne dental filling.	-	Excellent

7.	Menthol	Natural from oils of Mentha Spp. (Labiateae) of Synthetic menthol.
8.	Safrole	Odour of sassafras; obtained from rectified camphor oil
9.	Terpineol	A mixture of isomers; produced mostly synthetically.

Chiefly to relieve symptoms of bronchitis, sinusitis and similar conditions; used as inhalant, as pastilles, as ointment (with camphor and cineol) to chest and nostril. Applied to skin, it dilates the vessels causing sensation of coldness followed by analgesic effect. Relieves itching and used in creams, lotions or ointments, in pruritus and urticaria. Used for headache, rheumatic pains and neuralgia. It has carminative action	i) Menthol and Benzoin Inhalation. ii) Menthol and Eucalyptus Inhalation iii) Menthol and Pine Inhalation. iv) Vap. Menthol V) Nasal Drops vi) Ointments vii) Pastilles viii) Spray	Good
Properties similar to sassafras oil	-	-
Disinfectant and solvent properties, as flavouring agent.	i) Used in chloxymol solutions and similar Preparations.	-

Annexure XI

Oil of Citronella

Two types of oils of citronella are produced and marketed in the world trade i.e. Java type - produced from Cymbopogon winterianus Jowitt. and Ceylon type produced from Cymbopogon nardus Rendle. Java type is the most important oil produced on large scale in Indonesia, Taiwan, China, India, Guatemala and Brazil. Oil is also produced in Vietnam, Thailand, Argentine, Honduras and Mexico. Ceylon type is produced only in Sri Lanka.

In the recent past, due to emergence of turpentine products, citronella oil has acquired a limited scope but nevertheless is still one of the large volume essential oils trade in the world due to special odour characteristics of the isolates from this which are still preferred by some perfumers.

Zanzibar has a potential of producing this oil as it has suitable agro-climatic conditions, large sitillation capacity and a plan for soil conservation in which its cultivation will fit admirably. A brief mention of the cultivation practices is given:

Citronella - Java type is a perennial which needs tropical climate, regular and spread out rainfall throughout the year. It does not tolerate water logging and does not grow well on calcareous soils.

Propagation is by rooted slips which are taken from healthy bushes and planted at a spacing of 0.5 to 1.0 metres depending on soil fertility. More spacing is given in more fertile soils. For slopes, plants are put cross-wise to reduce soil erosion at the time of heavy rainfall. In the initial stages of growth, fields are kept clean of weeds; thereafter the plant spreads, acquires a bushy form and suppresses growth of weeds. Plant is soil exhausting and responds well to fertiliser. In the initial stages leaves are cut to induce better growth of the plant.

First harvest can be taken after about six months to nine months thereafter 4-6 crops can be had every year, for about next 4-5 years after which the grass and oil yield tapers down.

Oil content varies from 0.5 to 1.0 per cent, in a good field, except, during dry season oil content is much above 0.5 to 1.0 per cent. Under favourable and irrigated conditions as much as 200 kg oil per hectare can be obtained while under rainfed condition about 40 to 80 kg oil per hectare can be obtained.

The spent grass after distillation can be used as boiler fuel (after drying) or used for card board making on cottage scale. Spent grass can also be fed to dairy animals.

Oil can be packed in 205 litres drums after removing moisture and sediments.

Products Quality and Standard Specifications:

Citronella oils - both Java and Ceylon types are primarily assessed for the total acetylisable constituents, calculated as geraniol and aldehyde content, calculated as citronellal. Other factors taken into consideration are physico-chemical characteristics, cleanliness and appearance of the oil.

Separate standards for both Java type & Ceylon type of oils have been laid down by various countries and Organisation. Important ones are summarised hereunder:

Oil Type	Standard	Total Alcohols (as Geraniol)	Total Aldehydes (as Citronellal)
Citronella	EOA No.14	85-97%	30-45%
Java type	BS 2999/19:1972	85% Min.	35% Min.
	ISO. 3849: 1976	85% Min.	35% Min.
Citronella	EOA No. 12	55-65%	7-15%
Ceylon type	BS 2999/18:1972	59-65%	7-15%

Sri Lanka is the sole producer and exporter of Ceylon type oil of citronella. It is exported in three grades, i.e.

Common 50 per cent total alcohols

Ordinary 52.5 per cent total alcohols

Estate 55 per cent total alcohols

Level of alcohol content is the minimum percentage.

Main Market: Main consumers of citronella Java type are U.S.A. U.K., France, Federal Rep. of Germany, Netherlands, Switzerlands Japan, Mexico, Socialist countries of E.Europe and USSR, Spain, Italy and Belgium.

There is no scope for Ceylon type oil. Only Java type oil should be produced which has market spread over many countries.

Annexure XII

Eucalyptus Oils

Out of a large number of Eucalyptus species only a few are exploited commercially for their essential oils for pharmaceutical, perfumery and industrial use. The two most important types are:

1. Medicinal Eucalyptus Oils: This group is characterised by high content of cieole used as an ingredient in certain pharmaceutical products. Main species used for production of essential oils are:

	Cineol content
Eucalyptus globulous Labill.	70 - 80%
E. smithii R.T. Baker	75 - 80%
E. australiana Baker & Smith syn. E. radiata Sieb.	70 - 75%
E. dives Schaur var. 'e'	70 - 75%
E. polyprachtea syn. E. fruiticetorum	80 - 85%

(In trade, the term medicinal eucalyptus oil also embraces cineol-rich oil produced in China by rectification of the oil from Cinnamomum camphora).

2. Perfumery eucalyptus oils: Oil obtained from E. citriodora. Hook. is characterised by a high content of citronellal. (65 - 80 per cent) together with citronellol. E. macarthuri was also used earlier to produce an oil rich in geraniol and geranyl acetate.

3. Industrial eucalyptus oils: Certain species e.g. E. dives, E. australiana and E. numerosa yield oils rich in piperitone and phellandrene used in chemical industries.

The cineol rich oils are used in the pharmaceutical products, (losenges, pastilles, syrup for cough, colds and chest ailments as also some formulations for skin complaints) house hold products and in general perfumery and flavouring application (soaps, colognes, bath oils, air freshners, disinfectants etc).

The oil is used as such as also after rectification (to remove components having undesirable odour and to enrich with respect to cineol content). The oil from E. citriodora is used for soaps, perfumery compounds and disinfectant as also as a starting material for perfumery chemicals especially hydroxy citronellal, citronellol etc.

Production: World production of medicinal eucalyptus oil ranges from 1500-1700 tonnes, China being the major producer (about 1000 tonnes), Spain, (400 tonnes) Portugal (200 tonnes) and India (150-180 tonnes). In many countries oil production is a side product (from leaves) of the timber and pulp industry. Brazil now produces about 100 tonnes of oil where cultivation of Eucalyptus species has been taken up. South Africa where production of oil is based on E. smithii now exports about 200 tonnes of oil. Australian production has decreased considerably.

Medicinal Eucalyptus oil is traded on the basis of its cineol content; Spanish and Portugese oils are considered the best. Perfumery eucalyptus oil is characterised by its citronellal content ranging from 65-80 per cent.

Annual consumption (in tonnes) of all the eucalyptus oils are as under:

	Eucalyptus Oils		
Country	Medicinal	Perfumery	Indusrial
U.S.A.	230-250	20-30	10-20
U.K.	95-105	40-50	5
France	550-560	20-30	5
F.R. Germany	210-220	10	Negligible
Netherlands	50	10	"
Switzerlands	20-25	5-10	"
Others	200-350	-	-

Quality Assessment & Standards Specifications:

1. Medicinal Eucalyptus Oils: This type of oil is assessed primarily

on its content of cineole, odour, content of phellandrene and isovaleraldehyde are undesirable for certain uses, overall appearance, cleanliness, and certain physico-chemical characteristics. Following standards have been published:

Standards	Applying to oils from	Cineole content (%)
BS 2999/53:1975	E. globulous & some other species	70 Min.
LSO 770	E. globulous	70 Min.
1SO 3065	Australian	80 Min.
	Eucalyptus	85 Max.

Requirement of oils conforming to B.P. (1980) are more stringent than 1SO and B.S.

2. Oil of E. Citriodora: Oil is primarily assessed on its aldehyde content calculated as citronellal. Other characters are general appearance, cleanliness and certain physico-chemical characteristics.

Standards for the oil have been laid down by 1SO (1SO-3044), British Standards Institution (BS 2999/23) and the Essential Oils Assocn. of U.S.A. (EOA No. 130). Requirement for citronellal content differ somewhat in these standards are given under:

BS. 2999/23	67% Min.
1SO 3044	70% "
EOA.No. 130	65 to 85%

Eucalyptus species, which are quick growing species have become popular as an introduced cultivated species to meet the ever increasing demand for wood and pulp industries. Their cultivation has now been taken up under 'Social Forestry Programmes'. Broad requirement for cultivation are well drained, light soils, temperature range of 5°C to 30°C, rainfall of 50 to 150 cm. and not too severe a dry season. Details of cultivation are well recorded in literature. Among the medicinal eucalyptus,

E. smithii has shown greater resistance to drought than many others while E. globulous withstands better the low temperatures.

Propogation is normally from seeds, preferably through seed beds and nursery.

For raising Eucalyptus for wood purposes, a spacing of 2m x 7m is kept, using interspace for raising short duration crops i.e. corn, beans etc. For the purpose of essential oils, closer spacing of 1.0 to 1.5 x 3m is adopted. For the purpose of oil, copicing of leaves (with terminal branches) is adopted. First crop becomes available after 6-8 months after planting. Usually, 2 crops can be had every year. The material after distillation can be used as fuel for distillation. Harvesting and coppicing is adopted as per local conditions and requirements. Yield of oil per hectare varies from species to species. An idea can be had from the following data:

Species	Oil content from leaves (%)	Oil yield per hectare per year (kg)
E. citriodora	0.8-1.5	About 60
E. globulous	0.75-1.25	" 75
E. smithii	2	" 100
E. australiana	3-3.5	" 200
E. dives var 'C'	3-3.5	" 200

Annexure XIII

GUM NAVAL STORES

Turpentine & Rosin Industry

Production of rosin (brittle transparent solid) and oil of turpentine (clear, aromatic liquid) is an important world industry. These are obtained by steam distillation gum oleoresin produced by wounding the pine trees and are recovered in a ratio of 4:1. In the unprocessed form rosin and turpentine oil find extensive use such as in soap, paper, paint and varnish industries. They also form starting material for products like paper sizing material, adhesives, printing ink, rubber compounds and surface coatings. Turpentine oil composition varies according to the source of gum oleo-resin. It is, nevertheless, a versatile essential oil and its various isolate, primarily alpha and beta pinenes are the starting materials for fragrance, flavour industry, pharmaceuticals (vitamins), insecticides and polyterpene resins. Besides, the oil rich pine stumps from old trees give on solvent extraction products like wood rosin, wood turpentine, dipentene and natural pine oil.

Following species of Pinus are tapped in the world for the oleo-gum resin.

i) Pinus elliottii

ii) P. kesiya

iii) P. caribaea. var. hondurensis

iv) P. occarpa

v) P. roxburghii Sarg. syn. P. longifolia Roxb.

vi) P. insularis Endl. syn. P. khasya Royle.

The U.S.A., USSR, China and Portugal together account for over 80 per cent of the world rosin production estimated at about one million tonnes. The USA and USSR produce mainly tall oil rosin (a bye-product from the conversion of pine trunks to pulp by the sulphate process which

yields sulphate turpentine, tall oil rosin and tall oil fatty acids) and wood rosin for domestic consumption. Portugal and China with estimated output of 90,000 tonnes and 200,000 to 250,000 tonnes respectively, produce almost entirely gum rosin and meet world demand. World production of turpentine oil is closely linked on rosin production and is estimated at about 250,000 tonnes , half of which is sulphate turpentine. World production of these products is not able to cope up with the demand. World trade in rosin averages 350,000 tonnes, 60 per cent of which is gum rosin. Both China and Portugal export about 200,000 tonnes. Major consumers are Japan, Federal Republic of Germany, the U.K., France, Italy, and Brazil. Producing countries are also the consumers.

Yield of gum oleo-resin is influenced by several factors, primarily the species of the pine, the ambient temperature, rainfall. Yield of gum oleo-resin is greatly influenced by the basal diameter of the tree (in the U.S.A. a diameter of 23 to 25.5 cm at a height of 140 cm above the ground is considered the minimum size for economic tapping). Flow of gum oleoresin is dependent on the ambient temperature ; temperature of 21°C over a duration of 8 hours during the 24 hours period is the minimum for profitable tapping. Consequently tapping period during the year is limited depending on the location and weather. Normally, only one face is worked on young trees; larger tree having a diameter of about 35 cm at a height of 140 cm above ground are often tapped on two opposing faces and that too for a limited period not exceeding 4 years.

Tapping of gum oleoresin has an adverse effect on the growth of the tree. Therefore, tapping programme need to be regulated and restricted in case trees are to be utilised as timber or pulp making. However, tapping for 2 to 4 years before felling of the tree is considered economical.

Production: Production of gum oleoresin and hence of rosin and turpentine oil is a bye-product from the pine trees which are normally raised for timber and pulp. Hence, it not only gives additional products, revenue, fillip to various industries but also generates rural employment. Productive pine trees are those which are ready for felling. India, which produces gum oleo-resin from P. roxburghii consumes the entire production of about 40,000 tonnes of rosin and 10,000 kilo litres of turpentine oil which is less than the actual demand.

Production of Gum Oleo-resin: Production of gum-oleo-resin is comparatively simple and easy and is essentially a manual operation. Resin is obtained by "tapping" which involves removal of a section of bark of the tree near the base to prepare a 'face' wherefrom a white, viscous gum exudes which is collected in a cup attached below the 'face'. Use of sulphuric acid on the face induces additional and quick flow of the resin. Exuded gum which is collected in the cup is collected in a bucket which is poured in barrels of suitable sizes for transportation. The face being marked is extended in height each season till such time that tree is felled. /depends on Yield/ duration of tapping season, the basal diamter, size of the face and the tapping technique. Treatment with sulphuric acid yields about twice as much gum oleoresin as from untreated trees.

Pinus palustris and P. elliottii in U.S.A. yield on an average 4 k g of gum oleoresin per face per season. In case of P. roxburghii the yield is about 2.5 kg, 2.3-2.7 kg from P. insularis and about 1.25 kg from P. walliohiana in India.

Processing: Processing of gum oleo-resin into rosin and turpentine oil is essentially a steam distillation process, the turpentine oil comes over with steam while rosin remains back in the vessel wherefrom it is removed while in molten form.

Gum oleo-resin is first heated and diluted with turpentine oil (about 2 per cent), filtered to remove wood chips allowed to settle for some time to remove dirt etc. and fed into the distillation still. The mixture is first heated with close steam oil and then live steam passed through the mass. Distillation is continued till practically all the turpentine oil distills over which is recovered from the florentine flask. Molten rosin is run directly into metal drums or into moulds for subsequent packing.

One tonne of gum oleo-resin yield about 700 kg of rosin and 100-200 litres of turpentine oil.

In India the corresponding yields of rosin and turpentine oil are about 725-750 kg and 250 to 375 litres respectively.

Product Quality Assessment: Rosin is traded normally on the basis of colour, general appearance and softening point. Grading is established by reference to the official United States colour standards which range from X (the palest and most valuable), through WW-WG (common and desirable pale grades) to NM (medicine) and to the darker KE grades. Besides this rosin is evaluated on acid number, saponification number, content of unsaponifiable matter, ash content and occasionally fatty acids and the tendency to crystallise.

In general, products from U.S.A. (P.elliottii and P. palustris) and Portugal (P. pinaster) set the standard against which material from other sources are judged.

Colour standards prescribed for various grades of Rosin in India are laid in IS: 553-1969 by the Indian Standards Institution.

Specification for 'spirits of (gum) turpentine' have been published by British Standards Institution (BS.244 and 290:1962) and the American Society For Testing and Material (ASTM D-13-65) and others including

Indian Standards Institution for Indian Turpentine oil (IS:533-1973) who recognise 2 grades.

Turpentine oil is also used as a feed stock for conversion by chemical means into pine oil, fragrance and flavour materials, pesticides and resin derivatives. Suitability for and uses is determined by the chemical composition of turpentine oil which varies from species to species.

Considering the basic importance of gum oleoresin products, some further details are given:

To understand the difference in chemical composition of turpentine oil from various countries, following data is given:

Country	Content of (%)				
	Alpha Pinene	Beta Pinene	Δ- 3 Carene	Longifolene	Other Terpenes
U.S.A.	65-75	20-30	-	-	5
France	60	25-30	-	-	5-10
India	20-30	5-10	55-65	2-5	2-5
USSR	75	-	15	-	10
Portugal	80	15-17	-	-	3-5
Sweden	80	5	15	-	-
Japan	85	10	5	-	-

Alpha and beta pinene are the most valuable. However, in India, utilisation of Δ^3-carene and longifolene has been done so successfully that these are no longer considered of less importance.

List of products from turpentine constituents is too long to mention here. However, some of more important and common chemicals and products are also described here.

Uses of Turpentine Oil : Turpentine oil is widely used in paint, varnish and shoe-polish industries. It is also employed in pharmaceutical perfumery for making synthetic camphor and pine oil, insecticides, disinfectants and denaturants. In India, chlorinated turpentine (60-80 per cent chlorine) is claimed to be comparable to DDT in its action. Also use of turpentine oil from P. insularis has been recommended for extraction of quinine from cinchona with low alkaloids.

In pharmaceutical (turpentine oil is included in Indian Pharmacopoeia and I.P. Codex), the oil is used for its locally irritant and mild antispetic properties. The oil acts as a stimulant expectorant and is useful in chronic bronchitis and in gangrene of lungs.

It is used as a carminative in flatulent colic and also in typhoid. It is also used to arrest minor haemorrhage in tooth socket and nose. Externally, oil of turpentine is used as a rubefacient in the form of linements in rheumatic affections such as lumbago, arthiritis and neuralgia. As an enema the oil is considered useful in obstinate constipation, tympanitis and seatworm infestation. In the form of turpentine stupe, it is used as a counter irritant in deep seated inflammation particularly that of abdomen.

Synthetic Pine Oil : Pinenes along with longifolene and carenes are hydroxylated and etherified to yield a mixture of terpineols and terpene ethers which are the main constituents of natural pine oil(obtained by steam distillation of pine wood). The synthetic product is straw coloured liquid with pleasantly mild and aromatic odour. It compares well with the natural product and its uses. It can be used in paints and varnishes, lacquers, distempers, soaps and detergent, in perfumery and pharmaceuticals. Pine oil is also used in textiles, leather, insecticides paper and rubber industries (synthetic pine oil can be produced in good yield by homogenising

the oil with sulphuric acid and acetone, refluxing the reaction products, separation of acetone for re-use).

Turpentine oil as a source of Fragrance & Flavour chemicals: The terpenes, alpha and beta pinene, camphene, limonene, Δ-3-carene and longifolene have been subjected to a variety of reactions, yielding products like terpene alcohols, esters, ketones, aldehydes having diverse odours e.g. woody, camphoraceous, citrus, minty, grassy, earthy fruity and floral finding extensive uses in fragrance, flavour, pharmaceutical and polymers which are valuable ingredients in the manufacture of paint, varnish, adhesive and rubber goods.

Residue left after fractionation of turpentine oil commonly referred to as 'pitch' has been utilised in the manufacture of various grades of pine tars used in Rubber industry.

Rosin : Rosin constitutes main product from gum oleoresin processing. It is mainly used as a base in the manufacture of soaps and sizing of paper, rubber industry, in casein glues, as binder in roofing cements, in dry battery insulating composition, in soldering pastes and fluxes, in the manufacture of fireworks, match composition, shell explosives, insecticides and disinfectants and a host of minor uses.

More recently Japanese scientists have discovered that one of the four stereo-ismers of a diterpenoid (4B, 10 α dimethyl-1,2,3,4,5,10 hexahydroflourine-4 α., 6-dicarboxylic acid) synthesised from pine rosin has 1300-1800 times the sweetness of sucrose.

Annexure XIV

Lemongrass Oil

The lemon grass of commerce is produced by distillation of overground part of Cymbopogon flexuosus Stapf (East Indian Oil produced in India) and Cymbopogon citratus Stapf (West Indian oil produced in other parts of the world). Recently, another good source in Cymbopogon pendulus has been introduced in India and is being cultivated on large scale for good quality oil. All the three sources of lemongrass oil have high citral content of above 75 per cent.

Lemongrass oil is extensively used for ionones - both for perfumery as also for synthesis of vitamin A. The oil is also used in low cost fragrance applications, as an ingredient in aerosole deodrants, floor polishes, house hold detergents and host of other domestic and industrial products. Current international trade is around 500 tonnes of the oil, substantial quantities are, however, used in India for production of beta ionone for export. However, international trade can consume more quantities if produced elsewhere.

India is the largest producer, averaging 500 to 1000 tonnes per annum. Guatamala comes next with largest exports of about 250 tonnes. China has put another comparable oil in Litsea cubeba, exporting about 80 tonnes of the oil. Other producers are Sri Lanka, Brazil, Argentina, Haiti, Indonesia, Thailand but production in these countries ranges from 1 to 5 tonnes each.

Lemongrass is a good soil conservation plant and it is expected to do well in Zanzibar, where agro-climatic conditions are favourable for its growth. A brief description on its cultivation is, therefore, given hereunder:

Lemongrass requires a warm climate, regular rainfall but not excessive. In India it is grown in area receiving rainfall of 250 cm

per annum. Although the plant is not exacting in soil requirement, it is often grown on soils, of poor quality or areas susceptible to soil erosion. Water logging is injurious to the growth. Lemongrass is soil exhausting and responds well to fertilisers especially nitrogenous.

Lemongrass can be raised both from seeds and rooted slips; former is sown in the nursery or direct and rooted slips in the fields direct at the onset of monsoon. In the beginning, fields are kept weedfree, but does not need much attention once the plants pick up growth. First harvest can be taken at 6 to 8 weeks' interval. Every year, till next 5 years are so, 4 to 6 harvests can be taken. About 60-80 kg of oil can be produced per hectare per year from Cymbopogon flexuosus while much higher yields have been obtained from Cymbopogon pendulus in India. The spent grass 25-30 tonnes per hectare can be used either as boiler fuel or for cardboard making on cottage industry scale.

Oil is produced by steam distillation and the present distillation equipment available in Zanzibar can very well be used for this product. Oil can be packed in 205 litres drums after freeing the oil from moisture and sediments.

Product Quality Assessment and Standard Specifications:

Lemongrass oil is primarily assessed on its aldehyde content (as citral) and its solubility in 70 per cent alcohol. Most commercial oils contain 75 to 90 per cent aldehyde content. Oils of good solubility and good aroma are preferred for direct perfumery application. Other aspects of quality are appearance, cleanliness and physico-chemical characteristics.

International Standards Organisation (ISO), the British Standards Institution (BSI) the Essential Oils Association of America (EOA) and

the Indian Standards Institution (ISI) have laid down standards on lemongrass oil of both origins as:

Standards	Oil Types Specified
ISO 3217: 1974	C. citratus West Indian lemongrass
BS 2999/35: 1971	C. flexuosus - East Indian lemongrass
BS 2999/36: 1971	C. citratus. West Indian lemongrass
EOA No. 7	C. citratus and C. flexuosus specified separately within one document
IS: 327 - 1961 (revised)	C. flexuosus - East Indian lemongrass.

Annexure XV

Lime Oil & Lime Juice

Lime oils & lime juice are obtained from the fruits of Citrus aurantifolia Swingle, known as 'Key' or 'West Indian' or 'Mexican' lime tree and of C. latifolia Tan. known as 'Tahitian', 'Persian' or 'Seedless Lime'. The former is by far the most important of the two and is grown widely in the tropics. Tahitian lime which is somewhat larger fruit is mainly grown in sub-tropical areas, notably florida, it is the preferred fruit for the fresh fruit trade. The flavour character of the oil and the juice obtained from Tahitian lime is inferior to those of 'Key' limes, hence smaller demand but significant.

For reasons of economics, fruit is processed both for oil and juice. Several methods are employed for processing of the fruit.

Cold Pressed Oil: Cold pressed lime oil is comparatively a new product and is produced by careful expression of the oil from the peel, avoiding contact with the juice. Mexico produces about 50 tonnes of this oil which is about 10 per cent of its total lime oil production. Some cold pressed oil is also produced from Tahitian fruit.

Distilled Lime Oil: This oil comprises of bulk of world trade and is prepared by distillation of the juice obtained by crushing the whole fruit, either directly or after removal of the bulk of juice. Odour and flavour of distilled oil is markedly different from that of the cold pressed oil as a consequence of its contact with the acidic juice and heat treatment. Relatively small quantity of distilled oil is produced from Tahitian lime

Lime Juice: It is the clear acid juice of the fruit obtained as a co-product of either the cold pressed oil or distilled oil. Formerly, lime juice, obtained directly from the process termed as 'single strength

juice was marketed. However, bulk of the trade is now confined to four and six-fold strength juice.

Production and Trade: The pattern of supplies of both lime oil and juice has changed markedly in the recent past, new sources of production and supply have emerged.

Lime Oil: Total world production of all types of lime oil is about 1000 tonnes; about 900 tonnes enters international trade. Cold pressed oil amounts to a maximum of 100 tonnes only. The United States of America is the major consumer followed at a distance by United Kingdom.

Mexico is the largest producer, producing about 500 tonnes based on 'Key' lime bulk of which is distilled oil. West Indian Islands have been regular producer of this oil, exports have been in the range of 210 to 230 tonnes; Haiti accounts for 45 per cent of this. Other producers being Jamaica, Cuba, Trinidad, Tobago, the Dominican Republic, the Bahmas, and a few other islands. Peru is a recent entrant into this trade exporting about 30 to 40 tonnes. Brazil produces both for home market and export. Exports being of the order of about 40 tonnes. Cold pressed oil is mostly produced from Tahitian type lime.

Production in West Africa (Ghana, Gambia and Ivory Coast) is around 55 to 70 tonnes, Ivory Coast contributing about 40 tonnes. A few other countries i.e. the U.S.A., Argentina, Swaziland, Tanzania, India and Pakistan have also produced small quantities.

Lime oil is assessed for its odour and flavour primarily and also a few physico-chemical characteristics. Quality of Mexican oil is considered the best. Cold pressed oil has better, true to the fruit, odour and flavour character.

Lime Juice: Leading exporting countries are Mexico, Brazil, Ghana and the U.S.A. followed by Trinidad, Jamaica, the Windward Islands. Gambia and Tanzania. Only Brazil and the U.S.A. process 'Key' lime. Single strength

juice is hardly traded, only four to six fold strength juice is preferred in the international trade. Mexico is the largest exporter.

Total world trade in Lime juice ranged from 4,480,000 to 5,870,000 litres. Ghana and Mexico being the leading most. United Kingdom was the largest importer of concentrated and single strength juice (3,100,000 litres and 900,000 litres respectively, average of 1975-1980) importing mainly from Ghana, U.S.A., Mexico, West Indian Islands, Gambia and Tanzania. Import being mainly of 'Key' lime juice. Other importing countries of significance are U.S.A., Canada and Australia.

Lime juice is assessed first on its flavour character, clear appearance, the citric acid content.

By and large, existing production of lime oil in the world is adequate to meet the demand of the industry. As far as lime juice is concerned, there seems to be a situation of over supply; prospects of single strength juice are very poor.

Production & yield data: Normally one tonnes of lime fruit yields 4 to 8 kg of oil, mostly yields are lower than this.

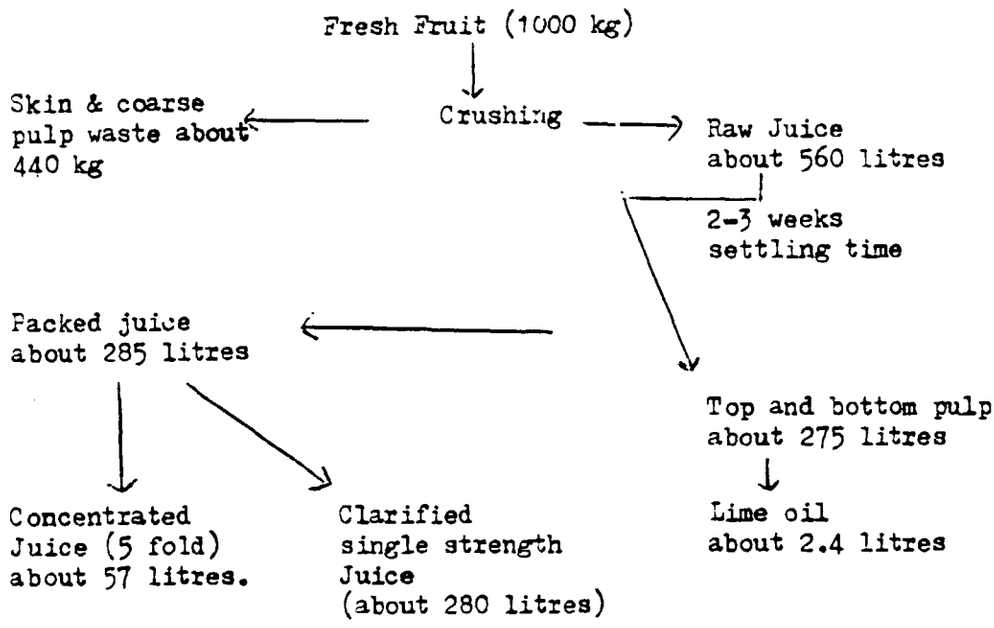
In case of distilled lime oil, oil is produced either by steam distillation of juice as such or of the top and bottom 'layers' after removing the middle layer which separates on long standing. Average yields are:

Fresh fruit (1000 kg) ⟶ Crushing ⟶ Raw juice (560 litres)

Crushing ↓ skin & coarse pulp waste about 440 kg

Raw juice (560 litres) → Distillation (about 3 litres of oil)

Production yield of both juice and lime oil are as under:



Standard Specifications & Quality Assessment

Cold Pressed Oil: This type of oil is assessed mainly on its odour and flavour character besides physico-chemical characteristics. Essential Oils Association of U.S.A. has laid down a standard (EOA No. 88) for oil from Key limes. British Standards Inst. (BS.2999/46:1972) has also laid down a standard for this type of oil. ISO and AFNOR Standards are also there.

Distilled Lime Oils: The oil is also assessed for odour, flavour and physico chemical characteristics. Standard for Key lime oil has been published by the EOA (EOA No. 78) and the British Standards Institution (BS. 2995/45: 1972).

Lime Juice: Lime juice is assessed on the basis of flavour, appearance (bright sparkling), citric acid content etc.

Annexure XVI

Patchouli Oil

Patchouli oil is obtained from the dried leaves of mainly Pogostemon cablin Benth (Fam. Labiateae). It is one of the most important essential oils used in the fragrance industry, as such, mainly in high price products including toilet soaps, perfumes, body lotions, pre & after shave lotions. Patchouli oil is unique and complex in nature and has not been affected or replaced by any synthetic substitutes.

Current world demand is of the order of little over 500 tonnes per annum with increasing trend . Indonesia is the major supplier of this oil, production averaging about 450 tonnes per annum, practically all of which is exported. Next to Indonesia, China produces about 50 to 80 tonnes per annum which is exported to developed countries mostly and to Malaysia and Singapore for further resale, with about 10-30 tonnes used locally.

Out of 500-525 tonnes of patchouli oil consumed in the world, U.S.A. alone consumes about 200 tonnes, other consuming countries are U.K., France, Federal Republic of Germany, Netherlands, Switzerland, India and Japan.

Patchouli oil is judged on its odour, Indonesian oil was considered the best but it is now mixed with gurjun balsam oil (to bring down price). Chinese oil is not considered as good as Indonesia oil but is considered free from adulterants and has of fairly consistent general properties and quality.

Patchouli has been considered as a shade loving plant. As such there is scope for its cultivation in Zanzibar as an under crop of coconut and young clove trees and orchards. A brief note on its cultivation is, therefore, given hereunder:

Cultivation: Pogostemon cablin is indigenous to the Philippines. It thrives best in a moist tropical climate with a well distributed rainfall of 150 to 300 cm per annum, lesser than 3 months dry period and a temperature range of 24-30°C. The plant can tolerate a wide variety of soil, but is susceptible to nematode attack. Crop rotation is essential with patchouli cultivation. Patchouli does not tolerate water logging.

Patchouli is propagated by stem cuttings which are put in a nursery for rooting. Young plants are set out into fields keeping spacing of 70 cm to 100 cm. Fields are kept woodfree, tended well and fertilisers applied if soil is not rich. Plants become ready for harvesting in above six month's time. Leaves are harvested before these become brown. Harvesting is done regularly, thereafter, at 3 to 4 months interval. This continues for about 3 years when plants are uprooted and some other crop raised.

After harvesting, leaves are shade dried prior to distillation. Fresh leaves are not distilled. Leaves can also be dried by air drying in racks. An yield of about 1500 kg of dry leaves can be harvested from one hectare, which in turn would give about 35-45 kg oil.

Distillation of patchouli is best done by steam. One charge may take 12 to 24 hours. Oil is separated, cleaned and packed.

Quality Assessment and Standard Specifications: Odour is the primary criterian for oil of patchouli, other factors being general appearance, cleanliness, and physico-chemical characteristics. Following stnadards have been laid down by:

E.O.A. No. 23
BS 2999/10, 1965
ISO. 3757: 1978 E.

All these standards are broadly same for physico-chemical characteristics. No distinction is, however, made on the basis of any geographical origin of patchouli oil.

Recently, gas chromatographic analysis technique has come into vogue for evaluating patchouli oil.

Annexture XVII

Vanilla

Vanilla beans of commerce are the cured fully developed fruit pods of certain species of Vanilla such as:

1. Vanilla fragrans (Salisb) Ames. Syn. V. planifolia Andrews, known as true vanilla grown in Malagassy and Comoro. Islands (for Bourbon vanilla) and Indonesia (for Java vanilla).

2. Tahiti vanilla is produced from V. tahetensis J.W. Moor. grown in mainly French Polynesia.

3. Vanillons (Gudeloupe or Antilles vanilla) is obtained from V. pompona Scheide and is grown on small scale only in the former French West Indian Islands, notably Guadeloupe.

Vanilla is one of the most popular flavours. The odour of Guadeloupe vanilla is floral and is almost exclusively used for fragrance. Producing countries produce vanilla in the form of whole or cut beans, and processing is undertaken in the consumer countries. Following products are made out of vanilla beans.

1. Vanilla powder usually incorporating sugar, food starch or gum acacia.

2. Vanila extract is the most common form of utilisation and is an aqueous alcoholic solution.

3. Vanilla oleo-resin is solvent extracted product from which solvent has been removed.

4. Vanilla tincture possesses higher alcohol content mainly used in the pharmaceutical industry.

In the fragrance industry, vanilla is used in the form of Perfumery Tincture containing about 90 per cent alcohol and as an absolute.

Synthetic vanillin supplies over 95 per cent of world requirement, even though it is comparable in odour with the true vanilla but is much

cheaper. Blend of natural vanilla and synthetic vanillin is also used in the industry.

World's 75 per cent requirement of natural vanilla comes from Indian Ocean Island especially Malagassy. Average world consumption of vanilla is around 2,000-3,000 tonnes valued at about US & 50-55 million. Production varies from year to year due to weather conditions e.g. production in Malagassy fell from 1300 tonnes in 1975 to about 380 tonnes in 1978. The United States of America consumes about 50 per cent of world production. Import of vanilla was as high as 1553 tonnes in 1977 which fell tl 343 tonnes in 1980 due to short supply. Other importing countries are France, F.R. Germany, Japan, U.K., European countries (Belgium, Denmark, Italy, Luxembourg and Netherlands), Switzerland, Saudi Arabia and Australia.

Demand for vanilla, inspite of competition from synthetic sources is fairly stable; price range being $ 60/kg or so. All the major producing countries have plans to boost production. There is considerable gap between demand supply; more vanilla production is required.

Quality Assessment and Standard Specifications: The primary quality criterian for vanilla beans is the flavour character and strength. The former is assessed subjectively while an objective determination of the vanillin content and oleo-resin extractive content is done for the latter. Besides these, other factors like moisture content, the general appearance and absence of mould and insect damage are also considered.

For retail sale, size and appearance of beans are most important factors (Top grade beans are unsplit, long, supple with a uniform dark colour, and an oily unblemished surface). Size of the bean ranges from 26 cm for top grade to a minimum of 12 cm in the lowest grade, of

whole and split beans. The moisture content of top grade bean is usually 30 to 40 per cent while the lowest grades and cuts contain as little as 10 per cent.

On the other hand, general appearance is of less importance for the manufacture of vanilla extract, oleo-resin and similar product; flavour character and strength, yield of extractive are more important factors.

In collaboration with the British Standards Association, the Association Francais de. Normalisation and other bodies, the International Standards Organisation has drawn up a specification "Vanilla - Vocabulary" (ISO 3495: 1976) which applies to "True Vanilla" and "Tahiti Vanilla". An identical British Standard (BS 5432: 1976) has also been laid down. The United States of America has specifications for vanilla products intended for flavouring purposes while France has regulations governing labelling purposes.

Special considerations for vanilla production: Under suitable agro-climatic conditions vanilla growing is very remunerative crop giving a gross return of US $ 2,500 to 4,000 per hectare per year. However, it is specialised crop, labour intensive and need specialised attention, especially in pollination, harvesting and curing; the latter being a long drawn process; for drying the beans after 'sweating' dryers would be necessary as weather under which vanilla grows best is not conducive to proper drying in short periods.

Annexure XVIII

Vetiver Oil

Oil of vetiver is produced from the roots of Vetiveria zizanoides (Linn.) Nash. Fam. Gramineae and is one of those important natural essential oils which is not affected by synthetic substitutes. The oil is primarily used in fragrance industry, small quantities are also used in cosmetics. Total world demand of finished products employing this oil is on the increase.

Current total exports are estimated to be over 250 tonnes per annum. U.S.A. and France being the main markets of the total global export, Haiti and Indonesia contribute some 40 per cent each, the balance contributed by the Reunion Islands and China.

While odour plays an important role, total alcohols and to an extent ester content are equally important. Oil from Reunion commonly known as 'Bourbon Vetiver Oil' has always been regarded as the best in the industry. As a matter of fact, odour characteristic is different in oil from different regions. It is, therefore, important to evaluate the existing genetic sources of the country prior to large scale production.

Vetiver can play a useful part in the soil conservation programme provided it is done systematically and scientifically. Crop age is normally 18 months for harvesting schedule and planning has to be done accordingly. A brief description of cultivation methods is given hereunder:

Cultivation: Vetiver is native to India and Southern Asia and grows well in the tropics and sub-tropics. Although it grows on almost all types of soils, rich and fairly well-drained sandy loam is considered the best. Annual rainfall of 100 to 200 cm is considered good with a temperature range of 20°C to 43°C.

Vetiver is propagated by small root fragments obtained from older plants at harvest time. The root fragments or slips are planted at 20 cm to 100 cm apart. Vetiver should not be planted in shade. Fields are needed to be kept clean with occasional hoeing and weeding. Weeding prior to harvesting is considered essential.

Vetiver is soil exhausting and besides application of fertilisers, crop rotation is considered beneficial.

Optimum growth period is 15 to 24 months. Over ground portion is cut prior to root digging. Roots are washed to remove adhering soil and dirt; shade dried prior to distillation. Oil content of about 2 per cent is obtained, and an average yield of about 20 kg oil per hectare.

Distillation of vetiver roots is not an easy and simple affair. Oil comes out over a long period of distillation, separation of oil water mixture is difficult and condensate is run at 50 to 60°C to facilitate separation using 2 to 3 florentine receivers. Longer distillation yield good quality oil and a duration of 16 to 24 hours is considered necessary. Product Quality and Standard Specifications: Vetiver oil which is used directly in fragrance industry is judged by its odour. Other aspects of standards are appearance, cleanliness and physico chemical characteristics. Where the oil is used for the isolation of vetiverol or to prepare vetiveryl acetate then besides odour, vetiverol content is of equal importance.

Standards for physical and chemical chateristics of vetiver oil have been laid down by the Essential oils Assocn. of America (EOA No. 24) and the British Standards Institution (BS. 2999/15 : 1965). Both the standards are nearly same.

In India there are 2 standards one for North (Wild growth) and

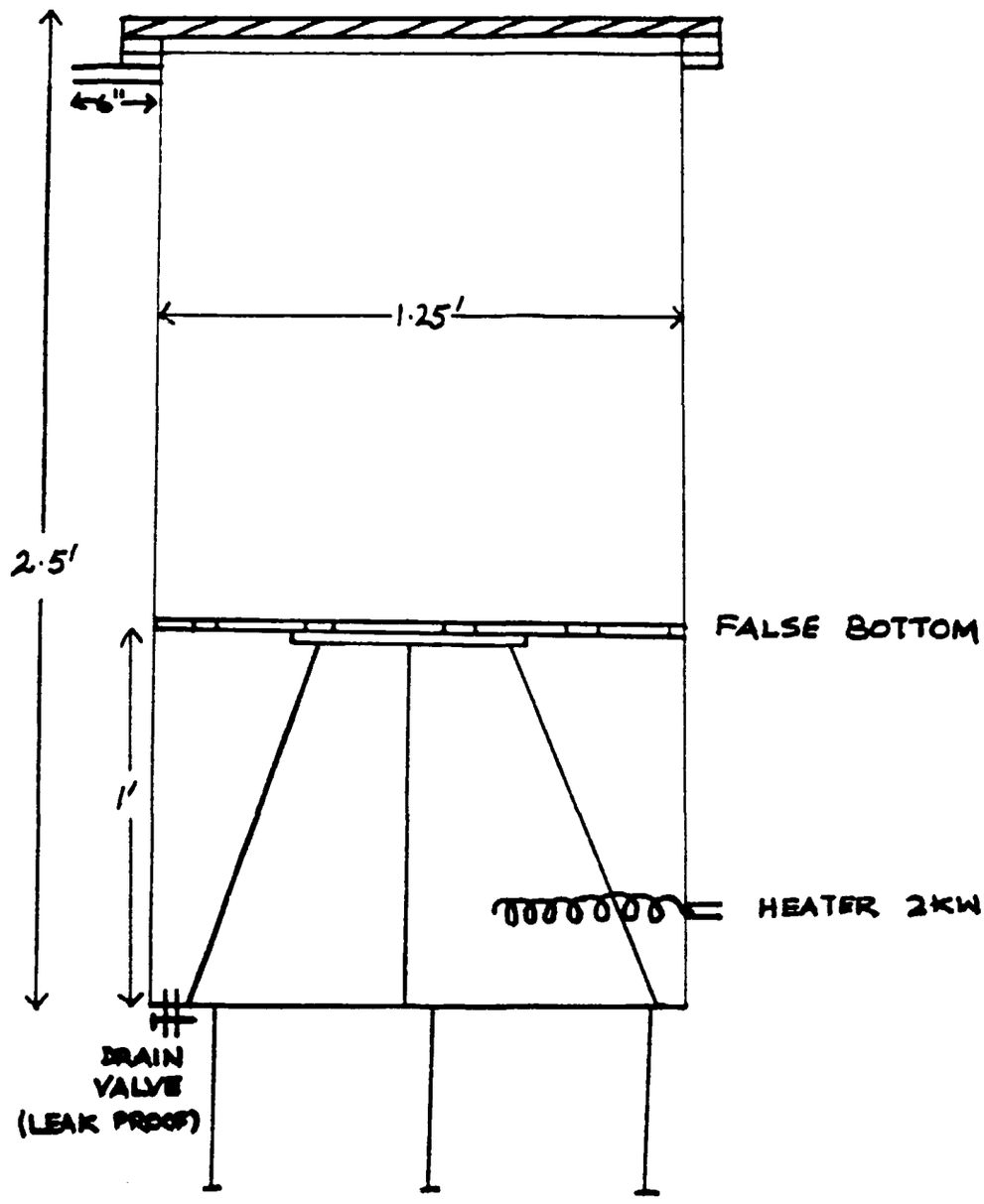
second for South India (cultivated). Besides other differences major difference is in the optical rotation (IS: 1177-1969).

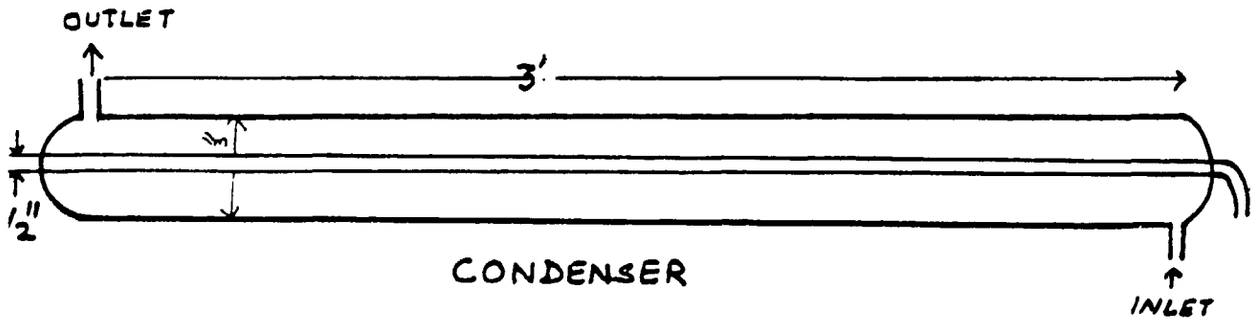
Prospects for vetiver oil in Zanzibar

Vetiver grows wild in Zanzibar and Pemba and it is important, as a first step to evaluate its quality with respect to both oil content and quality; if possible from different agro-climatic regions with an idea to select material for cultivation as and when required for large scale cultivation.

Annexure XIX

LABORATORY DISTILLATION UNIT DESIGNED FOR WORK IN ZANZIBAR





Annexure XX

Methods of Producing Starch from various raw materials:

Starch from maize: Shelled maize grains are screened to remove large and small pieces of cob, chaff, sand and other extraneous matter. Dust and light chaff are removed by steeping in sulphur deoxide water at about 50°C for 50 to 55 hours for optimum milling and separation of corn components. Soft grain so obtained is coarsely ground to separate germ which yield maize oil. After the separation of maize germ and fine grinding the starch milk so obtained is processed to remove coarse and fine fibre by screening. Finally, defibered mixture of starch and protein is separated in centrifugal starch separation machines taking advantage of difference of gravity of starch and gluton.

Starch from Tubers and Roots: Freshly dug root and tubers are washed and peeled in rotating washers and ground in raspers. The resulting starch milk is passed over vibrating screen to remove fine fibres, thereafter sieving operation is carried out thrice with different sieves and sulphur dioxide is added to improve colour and to prevent action of bacteria and mould. After final screening, starch is thickened and centrifuged, washed and dried in flash dryer.

Annexure XXI

Equipment for Starch Manufacture:

An idea about the list of equipment needed for the manufacture of starch from tubers of Tacca is given below:

1. Continuous Tumbler washer capacity 300 kg/hour.

2. Sand drum (continuous type) to remove skin, with 1 HP. 3 Phase motor, capacity 300 kg/hour.

3. Root cutter/slicer, I.H.P., 3 Phase. Capacity 300 kg/hour.

4. Rasper working on principle of Triple Roll Mills with one roller having projections (3 phases) Finger from the slicer fed directly to rasper, 3 HP. 3 phase.

5. Jet Homogeniser to homogenise the product from rasper and to facilitate separation of Milk and fabrous matter, 2 HP., 3 phase.

6. 1000 litre stainless steel tank, with bottom discharge valve and a tapping for water separation.

7. Vibrating sieve 12", ½ HP., mesh size 150.

8. Stainless steel tank as in No. 6

9. Vibrator as in No. 7 but sieve 250 mesh.

10. Stainless steel tank as in No. 6.

11. Vibrator, as in No. 8 but sieve 350 mesh.

12. Buchner having filter cloth of 500 mesh or centrifuge.

13. Cake drier (Trays - 40) 12 kw, 0-120°C with thermostatically controlled, Air, 2500 c/m, 1/2 HP static pressure ½" of water.

14. Micropulveriser to pulverize the dry starch, 7.5 HP speed 500 r.pm

Individual components could be assembled in developing countries

Annexure XXII

Classified List of Indian Standards on Natural and Synthetic Perfumery Materials Prepared by PCDC 18

1. Essential Oils

IS: 327-1961	Oil of lemongrass (East Indian Oil of lemongrass) (revised)
IS: 328-1957	Oil of eucalyptus (revised)
IS: 329-1961	Oil of sandalwood (revised)
IS: 512-1961	Oil of citronella (revised)
IS: 526-1968	Oil of palmarosa (first revision)
IS: 528-1970	Oil of peppermint (first revision)
IS: 533-1973	Gum spirit of turpentine (oil of turpentine) (first revision)
IS: 587-1965	Oil of geranium (revised)
IS: 761-1955	Oil of ginger
IS: 1177-1969	Oil of vetiver roots (cultivated and khus) (first revision)
IS: 1615-1970	Oil of Himalayan Cedarwood (first revision)
IS: 3146-1965	Oil of celery seed
IS: 3147-1965	Oil of dill
IS: 3398-1965	Oil of patchouli
IS: 5757-1971	Pine oil
IS 6617-1972	Oil of mandarin orange, cold pressed
IS 6698-1972	Oil of clove
IS 6699- 1972	Cinnamon leaf oil
IS: 9257-1979	Oil of Eucalyptus citriodora
*Doc:PCDC 18(43)	Tejpat leaf oil

+ Oil of Mentha piperita

+ Oil of coriander

+ Oil of cardamom

+ Oil of garlic

+ Oil of davana

2. Synthetic Perfumery Chemicals

IS : 553-1969	Rosin (gum rosin) (first revision)
IS : 1799-1961	Citral
IS : 1800-1961	Geraniol
IS : 1801-1961	Citronellol
IS : 1802-1975	Ionones (first revision)
IS : 3123-1965	Hydroxycitronellal
IS : 3124-1975	Terpineol (first revision)
IS : 3131-1965	Musk ambrette
IS : 3134-1965	Menthol
IS : 3145-1965	Musk xylol

* Draft standard finalized but not yet under print

+ Subject on programme of work

IS : 3130-1965	Linalyl acetate
IS : 3228-1965	Musk ketone
IS : 3241-1965	Geranyl acetate
IS : 3250-1965	Methyl ionone
IS : 3349-1965	Resinoid benzoin, pure
IS : 3504-1965	Thymol
IS : 3584-1966	Camphor
IS : 3858-1966	Benzyl acetate
IS : 3924-1966	Benzyl alcohol
IS : 3925-1966	Eugenol
IS : 3926-1966	Methyl cinnamate
IS : 3927-1966	iso-butyl phenyl acetate
IS : 3928-1966	Styralyl acetate
IS : 3929-1966	Amyl salicylate
IS : 4271-1967	Coumarin
IS : 4272-1967	Vanillin
IS : 4273-1967	iso-bornyl acetate
IS-4603- 1968	Phenyl ethyl alcohol
IS : 5164-1969	iso-borneal
IS : 5752-1970	Para para
IS : 5753-1970	Amyl cinnamic aldehyde
IS : 5754-1970	Phenyl acetic acid
IS : 5808-1970	Linalool
IS : 6760-1972	Benzophenone
IS : 7695-1975	Linalool, Synthetic
IS : 7696-1975	para-Cresyl methyl ether
IS : 7697-1975	Phenyl ethyl methyl ether

3. Methods of Sampling and Test

IS : 326-1968	Methods of sampling and test for natural and synthetic perfumery materials (under revision)
IS : 326(Part II)-1980	Preliminary examination of perfumery materials and samples
IS : 326(Part III)-1980	Relative density
IS : 326(Part IV)-1980	Determination of optical rotation
IS : 326(Part VII)-1980	Determination of acid value
IS : 326(Part VIII)-1980	Determination of ester value, content of ester and combined alcohols
IS : 326(Part IX)-1980	Determination of ester value after acetylation and free alcohols
IS : 326(Part X)-1980	Determination of residue on evaporation
IS : 326(Part XII)-1980	Determination of phenols
IS : 2284-1963	Method for olfactory assessment of natural and synthetic perfumery materials.

* Methods for organoleptic assessment of natural and synthetic perfumery materials.

4. Terminology

IS : 6597-1972	Glossary of terms relating to natural and synthetic perfumery materials.

5. Classification of Essential Oil-bearing Aromatic Plants.

IS : 6774-1972 Classification of essential oil-bearing aromatic plants.

Annexure XXIII

BRITISH STANDARDS ON ESSENTIAL OILS

BS	2999/20 : 1972	Oils of Clove bud
BS	2999/22 : 1972	Oil of Clove stem
BS	2999/21 : 1972	Oil of Clove leaf
BS	2999/54 : 1975	Oil of Clove leaf (Indonesian)
BS	2999/33 : 1971	Oil of Coriander
BS	2999/34 : 1971	Oil of Lavender (French)
BS	2999/37/38 1971	Oil of Nutmeg; East Indian and West Indian.
BS	2999/43 : 1971	Oil of Sweet Orange
BS	2999/39 : 1971	Oil of Peppermint
BS	2999/56 : 1975	Dementholised Peppermint Oil
BS	2999/14 : 1965	Oil of Spearmint
BS	2999/18 : 1972	Oil of Citronella - Ceylon Type.
BS	2999/8 : 1972	Oil of Citronella - Java Type
BS	2999/35/36 1971	Oil of Lemon grass (East Indian and West Indian).
BS	2999/28 : 1972	Pimento Fruit Oil
BS	2999/29 : 1972	Pimento Leaf Oil

Annexure XXIV

ISO Standards on Essential Oils Prepared by ISO/TC 54

ISO/R 210-1961	Essential oils - packing
ISO/R 211-1961	Essential oils - labelling and marking containers
ISO 212-1973	Essential oils-Sampling
ISO/R 278-1962	Standard layout for methods of analysis of essential oils.
ISO/R 279-1962	Determination of the density and relative density of essential oils
ISO 280-1976	Essential oils-Determination of refractive index
ISO 356-1977	Essential oils - Preparation of test sample
ISO/R 590-1967	Oil ofBrazilian sassafras
ISO/R 592-1967	Determination of the optical rotation of essential oils
ISO/R 709-1968	Determination of ester value and calculation of ester content of essential oils
ISO/R 770-1968	Oil of Eucalyptus globulus
ISO/R 855-1968	Oil of lemon, expressed Italy
ISO/R 856-1968	Oil of peppermint, France, Italy, United Kingdom and USA
ISO/R 875-1966	Determination of solubility of essential oils in ethanol

ISO	1041-1973	Essential oils- Determination of freezing point
ISO/R	1202-1970	Essential oils- Determination of cineole content
ISO/R	1241-1971	Essential oils-Estimation of free alcohols content by determination ester value after acetylation.
ISO	1242-1973	Essential oils - Determination of the acid value .
ISO	1271-1972	Essential oils- Determination of carbonyl compounds content-Free hydroxylamine method
ISO	1272-1973	Essential oils- Determination of phenols content
ISO	1279-1973	Essential oils-Determination of carbonyl compounds content - Hydroxylammonium chloride method.
ISO/R	1342-1971	Oil of rosemary
ISO	3033-1975	Oil of spearmint
ISO	3043-1975	Oil of pimento berry
ISO	3044-1974	Oil of Eucalyptus citriodora
ISO	3045-1974	Oil of bay
ISO	3052-1975	Oil of grapefruit (obtained by expression)
ISO	3054-1976	Oil of lavandin abrialis
ISO	3061-1979	Oil of black pepper

ISO	3062-1974	Oil of sandalwood (Eucarya spicata), Australia
ISO	3064-1977	Oil of petitgrain Paraguay
ISO	3065-1974	Oil of Australian Eucalyptus, 80 to 85 per cent cineole content
ISO	3140-1976	Oil of sweet orange, obtained by expression
ISO	3141-1975	Oil of clove leaf
ISO	3142-1974	Oil of clove bud
ISO	3143-1975	Oil of clove stem
ISO	3214-1974	Oil of litsea cubeba
ISO	3215-1974	Oil of nutmeg
ISO	3216-1974	Oil of nutmeg
ISO	3216-1974	Oil of cassia
ISO	3217-1974	Oil of lemongrass (Cymbopogon citratus)
ISO	3218-1976	Essential oils- Principles of nomenclature
ISO	3475-1975	Oil of aniseed
ISO	3515-1976	Oil of French lavender
ISO	3517-1975	Oil of nerol
ISO	3518-1979	Oil of sandalwood (Santalum album Linnaeus)
ISO	3519-1976	Oil of lime, obtained by distillation
ISO	3523-1976	Oil of cananga
ISO	3524-1977	Oil of cinnamon leaf
ISO	3525-1979	Oil of amyris
ISO	3526-1976	Oil of Spanish sage

ISO	3527-1975	Oil of parsley fruit
ISO	3528-1977	Oil of mandarin, Italy
ISO	3756-1976	Oil of cubeb
ISO	3757-1978	Oil of patchouli
ISO	3760-1979	Oil of celery seed
ISO	3761-1976	Oil of rosewood, Brazil
ISO	3793-1976	Essential oils-Estimation of primary and secondary free alcohols content by acetylation in pyridine
ISO	3794-1976	Essential oils (containing tertiary alcohols)- Estimation of free alcohols content by determination of ester value after acetylation
ISO	3809-1976	Oil of lime (obtained by expression of the whole fruit)
ISO	3812-1976	Essential oils of geranium and rose- Determination of ester value after hot formylation
ISO	3848-1976	Oil of Java citronella
ISO	4096-1978	Essential oils (containing tertiary alcohols) Evaluation of free alcohols content by determination of ester value after cold formylation.
ISO	4715-1978	Essential oils- Quantitative evaluation of residue on evaporation
ISO	4731-1978	Oil of geranium
ISO	5991-1979	Essential Oils- Determination of residue from distillation under reduced pressure.

PHYSICO-CHEMICAL PROPERTIES OF ESSENTIAL OILS : (BRITISH PHARMACOEIA 1980 VOL. I)

	Essential Oil of	Description	O.R.	R.I.(20°)	S.(20°)	D.(20°)	Others
1.	Anise	Colourless or pale yellow liquid, odour of crushed fruit, taste, sweet, and aromatic, crystallises on cooling.	-2° to +1°	1.553 to 1.560	1:3 in 90%	0.978 to 0.992	Freezing point not below 15°
2.	Caraway	Colourless or pale yellow liquid, odour characteristic.	+ 74° to + 80°	1.485 to 1.492	1:7 in 80%	0.902 to 0.912	Ketone content, calculated as carvone : 53.0 to 63.0% (W/W)
3.	Cardamom	Colourless or pale yellow liquid odour pungent and aromatic	+ 20° to + 44°	1.461 to 1.467	1:6 in 70%	0.917 to 0.940	Ester value 90 to 156
4.	Cinnamon	Yellow liquid becoming radish brown with age, odour characteristic	0° to - 2°	1.573 to 1.600	1:3 in 70%	1.000 to 1.040	Aldehyde content 60.0% to 80.0% calculated as cinnamaldehyde.
5.	Clove	Colourless or pale yellow liquid, odour and taste of that clove.	0° to -1.5°	1.528 to 1.537	1:2 in 70%	1.041 to 1.054	Alkali insoluble matter 1.0 to 1.5 in 10 ml. of oil in 5% KOH.
6.	Coriander	Colourless or pale yellow liquid, odour and taste those of coriander.	+8° to +12°	1.462 to 1.472	1:3 in 70%	0.863 to 0.870	-

7. Dill	Colourless or pale yellow liquid, odour characteristic of crushed fruit	+ 70° to + 80°
8. Eucalyptus	Colourless or pale yellow liquid, odour aromatic and camphoraceous, taste, pungent and comphoraceous, followed by a sensation of cold.	0° to + 10°
9. Lemon (Peel oil by expression)	Pale yellow or greenish yellow liquid, odour, reminiscent of lemon.	+ 57° to + 65°
10. Lemon - (Terpeneless)	Colourless or pale yellow liquid, odour, and taste of lemon.	- 5° to + 2°
11. Nutmeg i) East-Indian	Colourless, pale yellow or pale green liquid; odour, that of nutmeg	+ 10° to + 25°
ii) West Indian	- do -	+ 35° to + 45°

1.481 to 1.492	1:1 in 90% 1:10 in80%	0.895 to 0.910	Carvone contents: 43.0 to 63.0% (W/W).
1.458 to 1.470	1:5 in 70%	0.906 to 0.925 (Relative density)	Aldehydes and Phellandrene to be tested. Cineol content not less than 70%(W/W).
1.474 to 1.476	1:12 in 90%	0.850 to 0.856	Non-volatile matter 0.10 to 0.15 g. in 5.0 g. of oil; Aldehyde content: not less than 3.5% (W/W) calculated as citral.
1.475 to 1.485	1:1 in 80%	0.880 to 0.895	Aldehyde content: not less than 40% (W/W) calculated as citral.
1.475 to 1.488	1:3 in 90%	0.885 to 0.915	Evaporation residue: not more than 60 mg. in 2.0 g of oil.
1.472 to 1.477	1:7 in 90%	0.842 to 0.848	

12.	Orange	Yellow to yellowish brown liquid: odour, characteristic.	+ 94° to + 99°	1.472 to 1.476	1:7 in 90%	0.842 to 0.848	Non volatile matter: 20mg. to 100 ml. from 2.0g. of oil
13.	Orange (Terpeneless)	- do -	Note more than+60°	1.461 to 1.473	1:1 in 90%	0.855 to 0.880	Aldehyde content: not less than 10% (W/W) calculated as decanal.
14.	Peppermint	Colourless pale yellow or greenish yellow liquid, odour characteristic, taste, characteristic followed by a sensation of cold	- 16° to - 30°	1.460 to 1.467	1:4 in 70%	0.900 to 0.912 (Relative density)	Esters calculated as menthyl acetate 4.5 to 10.0% (W/W); not less than 44% (W/W) of free alcohols calculated as menthol; ketone content 15.0 to 32.0% (W/W) calculated as menthone.
15.	Spearmint	Colourless, pale yellow or greenish-yellow liquid when recently distilled, becoming darker and viscous on keeping; odour of spearmint.	- 45° to - 60°	1.484 to 1.491	1:1 in 80%	0.917 to 0.934	Carvone content: not less than 55.0% (W/W)

N.B: OR= Optical Rotation; R.I. = Refractive index; S= Solubility in ethanol;

D = Weight per millilitre.

GENERAL QUALITY CONTROL SPECIFICATIONS OF SPICES

Test	Black Pepper	White Pepper	Nutmeg	Macon	Cinnamon	Clove	Ginger	Pimento	Cardamom
Non-volatile ether extract	6-9.5	7-10	≤ 25.0	≤ 20.0	0.5-4.5	4-10	3-8	3-6	≤1.5
Starch (carbohydrates)	≤30	≤ 52	—	—	—	—	≤40	—	—
Total Ash	4-8.0	0.5-3.5	2-5.0	2-3.0	2-5.0	5-8.0	4-7.0	4-6.0	3-8.0
Acid Insoluble Ash	0.2-1.5	0.1-0.3	0.1-0.6	0.1-0.5	0.4-2.0	0.1-0.6	0.1-2(	0.1-0.4	0.5-3.0
Volatile Oil	2-3	≤ 1.0	≤ 7.0	≤ 8.0	see Table 1.5	≤ 15.0	≤ 2.0	≤ 3.0	≤ 3.0
Water content	≤10.0	≤ 12.0	≤ 8.0	≤ 8.0	≤ 11.0	≤ 8.0	≤10.0	≤ 8.0	≤ 11.0
Crude Fiber	≤11.0	≤ 5	5-10	4-10	—	≤ 10.0	≤8. 0	≤ 25.0	≤ 30.0

PHYSOCHEMICAL PROPERTIES OF THE SPICES ESSENTIAL OILS *

Oil	Specific Gravity	Specific Rotation	Refractive Index	Solubility in aq. Ethanol	Assay
Clove bud	1.036-1.060	-1°30' to 0°	1.527-1.537	1:2 vols 70%	85-92% phenols by vol.
Clove leaf	1.038-1.068	-2° to 0°	1.531-1.535	1:2 vols 70%	84-88% phenols by vol.
Clove stem	1.048-1.056	1°30'to0°	1.534-1.538	1:2 vols 70%	88-95% phenols by vol.
Nutmeg E.I.	0.880-0.910	+8°to +30°	1.474-1.488	1:4 vols 50%	----------
Nutmeg W.I.	0.854-0.880	+25° to 45°	1.469-1.476	1:4 vols 50%	----------
Mace E.I.	0.880-0.930	+2° to 30°	1.474-1.488	1:4 vols 50%	----------
Mace W.I.	0.854-0.880	+2° to + 45°	1.469-1.480	1:4 vols 50%	----------
Pimento leaf	1.040-1.053	+0°30' to -2°	1.531-1.536	1:2 vols 70%	80 - 91% phenols by vol.
Pimento berry	1.021-1.051	0° to + 4°	1.527-1.540	1:2 vols 70%	≤ 65% phenols by vol.
Pepper black	0.864-0.884	-1° to -23°	1.479-1.489	1:3 vols 95%	----------
Ginger root	0.871-0.882	-28° to -45°	1.488-1.491	----------	----------
Cardamom seed	0.917-0.947	+ 22° to 44°	1.463-1.466	1:5 vols 70%	----------
Cinnamon leaf	1.030-1.060	-2° to + 1°	1.529-1.540	1:2 vols 70%	≤ 80% phenols by vol.
Cinnamon bark	1.010-1.030	-2° to 0°	1.573-1.591	1:3 vols 70%	55-76% aldehydes calcd.
Cassia-cinnamon bark	1.045-1.063	-1° to + 1°	1.602-1.614	1:2 vols 70%	≤ 80 % aldehydes calcd. as cinnamaldehyde

* all oils should comply with the following standerds: Arsenic: 3 ppm. , Heavy Metals: 40ppm. and Lead: 10ppm.
(Source:Perfumer and Falvourist, Vol I, December/January 1977)

Annexure XXVII

Important aspects of analysis of essential oils:

Physico-chemical Properties

It is important to determine both the physical and chemical properties of the oil.

Physical Properties: Physical properties of an essential oil are:

1) Specific gravity at a specified temperature
2) Optical rotation
3) Refractive index at a specified temperature and
4) Solubility in dilute alcohol (of known strength) at a specific temperature.

Procedures for determining the above as also for chemical characteristics are well documented in standard books, and some pharmacopoeias such as British Pharmacopoeia, and Standards published by some countries and associations e.g. India, U.S.A., International Organisation for Standardisation (ISO). However, a brief mention is made on some important aspects of the analysis of essential oils.

1. Specific Gravity — Specific gravity is an important characteristics of an essential oil, it is normally less than 1 but sometimes more than 1 such as in oils of cloves and pimento. Specific gravity is normally taken at 15°C, sometime even at higher temperature. In general, it can be taken at room temperature, applying correction factor to bring the value at 15°C or any other temperature specified in a particular standard. Correction factor is generally indicated in the standard adopted; however, a general correction factor is also used if such factor for the essential oil under examination is not known. Correction factor per degree centigrade for a number of essential oils are given in standard books.

For determining specific gravity, specific gravity bottle of the size varying from 5 ml to 50 ml may be used depending on the size of the sample of oil. For laboratory size samples pycnometers are of great help which need oil even less than one gramme.

Calculating specific gravity is simple i.e. weight of oil divided by weight of water for the same volume at a specific temperature gives value of specific gravity.

2. Optical rotation — Most of the essential oils have property of rotating the plane of polarisation of a beam of polarised light either to the right or to the left, the extent of which is determined by the use of polarimeter under sodium light. Determination is done in a tube of 100 mm length. For smaller quantities of oil, tubes of smaller length are used but the value is always corrected to 100 mm length. Optical rotation is mostly reported at 20°C, even though most of the essential oils do not change in optical rotation at different temperature except some oils e.g. of citrus species. Determination of optical rotation is done in a dark room.

The oil is termed dextro rotatory if rotation is on right side and laevo rotatory if it is rotated on the left side.

3. Refractive index — Refractive index is another useful character of an essential oil. For this property, use of refractometer (Abbe's type) gives immediate results using only a drop or two of the oil. The value is determined normally at 20°C using mono-chromatic sodium light. If the refractive index is taken at temperature other than 20°C or any specified temperature, a correction factor may be used. Value of such correction factors are given for many essential oils. A general

correction factor of 0.00045 per C° may be used for new essential oils.

4. Solubility in Ethanol — Essential oils are soluble in dilute alcohol of various strengths. This is an important criteria and must be determined; various standards laid down by different countries specify not only the strength of the alcohol to be used for this test but also the volume of alcohol in ml to dissolve one ml of the oil. Here also temperature plays its role as solubility increases with increase in temperature. In general, oil rich in oxygenated components are more soluble in dilute alcohol than oils rich in terpenes.

Solubility in alcohol is one of the important tests to detect cases of adulteration which is, however, not discussed further here.

Solubility also indicates if the oil is old resulting in polymerisation which decreases solubility. Improper storage normally enhances polymerisation.

Solubility test is simple to perform; a 10 ml graduated cylinder is used. One ml of oil is taken and small quantities of dilute alcohol of requisite strength is added till oil completely dissolves. Observations are also made if any insoluble portion of the oil separates. However, observations are made till all the 10 volumes of alcohol are added noting down opalescense, cloudiness etc. with the subsequent addition of alcohol.

Other tests — Besides the above tests, some other tests may also be required e.g. congealing point, melting point (in case of solids), solubility in other solvents, evaporation residue, flash point, boiling range which are not frequently used and are not relevant to the essential oils indicated for use/work in this Project.

Chemical Properties: Main chemical characteristics to be determined in the essential oils are as under:

1) Acid calue
2) Ester value
3) Ester value after acetylation
4) Carbonyl value (or content)
5) Phenols
6) Determination of content of some important Constituents e.g.
   i) Cineol in Eucalyptus oils
   ii) Ascaridole in Chenopodium oil
   iii) Camphor in camphor rich oils

1. Acid value: Acid value or acid number is defined as number of miligrams of potasium hydroxide req uired to neutralise free acids present in one gm of the oil. Weighed quantity of the oil is dissolved in alcohol of 95 per cent strength; alkali of O.I.N. strength is used for tiration using phenolphthalein as indicator. Acid number is calculated as:

   Acid number = $5.61 \frac{\text{(No. of ml. of O.1N NaOH)}}{}$

   Reagents needed: O.1N NaOH
   Phenolphthalein, Rectified Spirit

2. Ester value: Ester value or ester number is defined as number of milligrammes of potassium hydroxide to saponify esters present in one gramme of the oil. It is also customary to report ester content by calculating the esters as single ester of an alcohol.

   The weighed quantity of the oil is first neutralised with dilute alkali the free acids present, and then refluxed with known valume of 0.5N alcoholic potash for a specified time, normally one hour but more for certain esters. Unused alkali is titrated back with O.5N hydrochloric

acid using phenolphthalein as indicator. Ester number is calculated as:

$$\text{Ester number} = \frac{28.05 \times \text{Number of c.c. of alkali consumed for saponification.}}{\text{weight of oil in grammes}}$$

Ester content of the oil is calculated as:

$$\text{Percentage of Ester} = \frac{\text{Number of cc of alkali used for saponification} \times \text{Molecular weight of the ester}}{20 \times \text{weight of oil in grammes}}$$

It is necessary to consult the standards of a particular oil for using specific conditions and the molecular weight of the ester to determine both the ester number and the ester content.

3. Ester value after acetylation: Ester value after acetylation of an essential oil indicates the content of alcohols present in free form as also in combined form. Procedure depends on the conversion of free alcohols to ester (as acetate) and saponification of the esters as done in the determination of Ester value.

(By definition also, ester value after acetylation is the number of milligrams of potassium hydroxide required to saponify ester in one gram of acetylated oil).

It is important to follow exactly the conditions of acetylation i.e. for 10 cc of oil, 10 cc of acetic anhydride and 2 gm of fused sodium acetate and reflux for 1 hour, except in certain oils where refluxing may be required for more time. These are specified for various essential oils in Standards.

In case of essential oils where ester number is negligible, the content of free alcohols may be calculated as:

$$\text{Percentage of alcohol in the oil} = \frac{am}{20\,(3-0.021\,a)}$$

Where

a = number of ml. of 0.5^N sodium hydroxide solution required to saponify esters in the acetylated oil.

m = molecular weight of the alcohol

s = weight of the acetylated oil in grammes used.

In case where the ester number of the oil under examination is appreciable, the content of free alcohol can be calculated as:

$$\text{Percentage of free alcohol} = \frac{dm}{561.04 - 0.42d}$$

Where

d = Ester number after acetylation - ester number

From the above analysis, it is also possible to calculate the percentage of total alcohols i.e. percentage of free alcohol plus the alcohol present as ester form.

$$\text{Percentage of total alcohol} = \left(\frac{am}{20\,(s - 0.21a)}\right)1 - \frac{42.04e}{100\,(m - 42.04)}$$

Where

e = Ester content in per cent

4. Estimation of Cabonyl Compounds: Some of the important essential oils are rich in aldehydes and ketones and estimation of their content becomes necessary e.g. lemongrass for citral, citronella and Eucalyptus citriodora for citronellal, mint oils for menthone, spearmint for carvone and so on. Most important methods of estimation are:

i) Sodium bisulphite method

ii) Sulphite method

iii) Hydroxylamine methods

i,ii) Bisulphite method is based on the principle that carbonyl compound forms a water soluble aduct with a hot saturated solution of sodium bisulphite,

while the non carbonyl compounds remain unreacted by the use of a cassie flask, the volume of unreacted oil is measured thereby content of carbonyl content (V/V) is estimated.

Neutral sodium sulphite method is also based on the above reaction i.e. carbonyl compounds make an aduct which is soluble in aqueous solution, the untreated portion of the oil is measured by the use of a cassia flask which gives content of carbonyl compounds (V/V).

iii) Hydroxylamine methods: While the above mentioned procedures give content of carbonyl compounds by volume, estimation by hydroxylamine methods give not only more accurate results but also give percentage content by weight. This procedure is also of advantage as smaller quantities of oil are used (about 1 gm of oil) as against 10 ml of oil used for bisulphite and sulphite methods (Besides, reaction time is shorter, non-carbonyl water soluble components do not react and are, therefore, not taken into calculations or as apparent aldehyde or ketone content). On the other hand, the main disadvantage is that a mixture of aldehydes and or ketones are calculated in terms of a single components; Carbonyl compounds of lower molecular weight, present as a natural component or by adulteration indicate results on higher level than actual.

In the reaction, free hydrochloride acid is liberated which is either titrated against 0.5^{N} sodium hydroxide or free acids liberated is reacted with excess alkali and the unused alkali titrated against standard hydrochloride acid.

Percentage of carbonyl compound is calculated as:

$$\text{Percentage of carbonyl compound} = \frac{am}{20S}.$$

Where:

a = Number of c.c. of 0.5 N sodium hydroxide used

m = Molecular weight of the compound

s = weight of oil in grams

In this procedure, determination of end point of titration has to be observed carefully; it is important to titrate both the blank and actual to the same end point.

5. Estimation of Phenols: Phenol react with alkali and form water soluble phenolates. However, other water soluble components and acids will also add on to the results of phenol percentage. In spite of this, the method is widely used. This method also permits study of non phenolic compounds if such examination becomes necessary.

For estimation of phenols, cassia flask with graduated neck in 0.1cc division is used. Alkali, 3 per cent sodium hydroxide or 5 per cent potassium hydroxide is used taking 10 cc of oil measured by pipette. Unreacted portion of the oil comes on top and is brought to the neck of flask. Unreacted oil is measured; deducting it from 10 cc (oil used) gives the percentage (after multiplying by 10) of phenols.

6. Estimation of Cineole: Freezing point of the oil containing cineole is an indication of its content of cineole. Content of cineole is noted from the table giving freezing point with the corresponding content of cineole.

Alternatively, melting point of O-cresol-cineole aduct gives fiarly accurate idea of cineole content. Another reliable method is forming solid aduct of cineole with phosphoric acid, removing the

aduct and liberating cineol by using warm water. This is done in cassia flask where cineole is brought up to the graduated neck, reading the actual volume of cineole liberated.

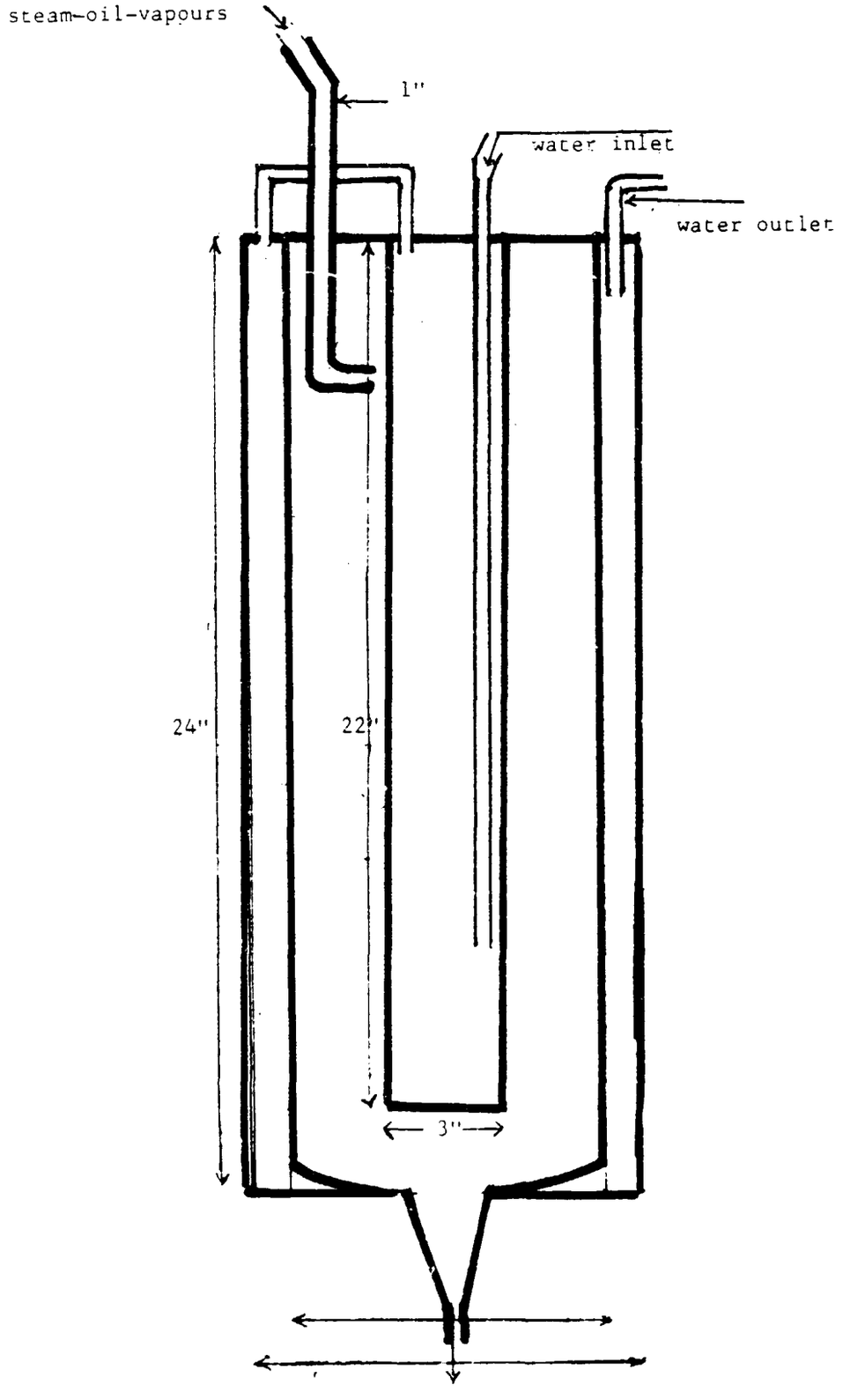
Estimation of Ethyl Alcohol content in Tinctures

Determination of the content of ethanol in tinctures is important. Basic principle is to separate the ethanol and determine the specific gravity and refracture index of the separated ethanol and water which gives fairly accurate idea of its content. The volatile substance i.e. essential oils are separated using a solvent like heptane or petroleum ether, ethanol being more soluble in aqueous phase, saturated solution of salt used in this case.

Alternatively, ethanol can be estimated using Gas Liquid chromatogram.

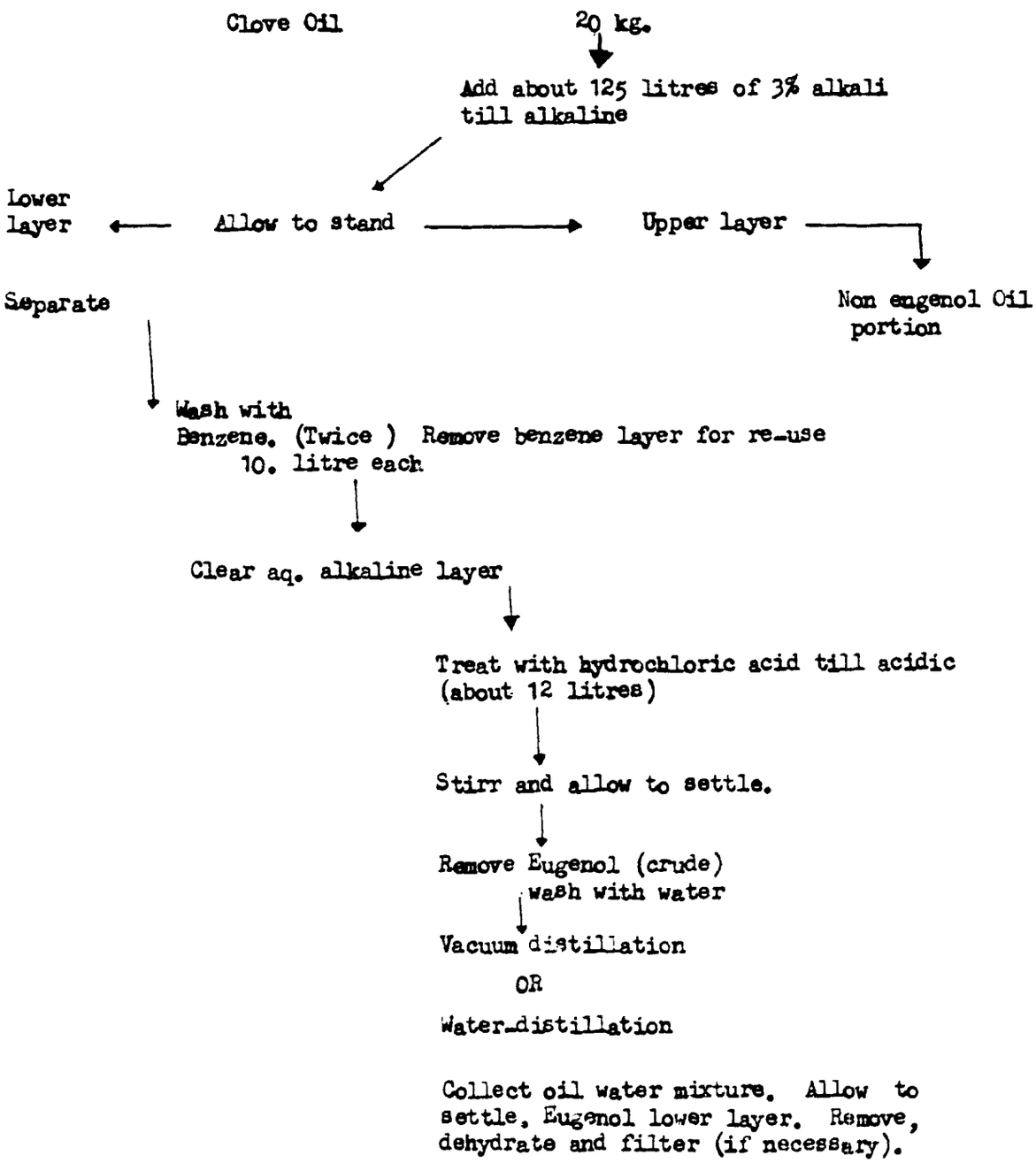
Annexure XXVIII

CONDENSOR FOR CAMPHOR RICH OIL
(copper or G.I.sheet)



Annexure - XXIX

FLOW SHEET DIAGRAM: EUGENOL FROM CLOVE LEAF OIL

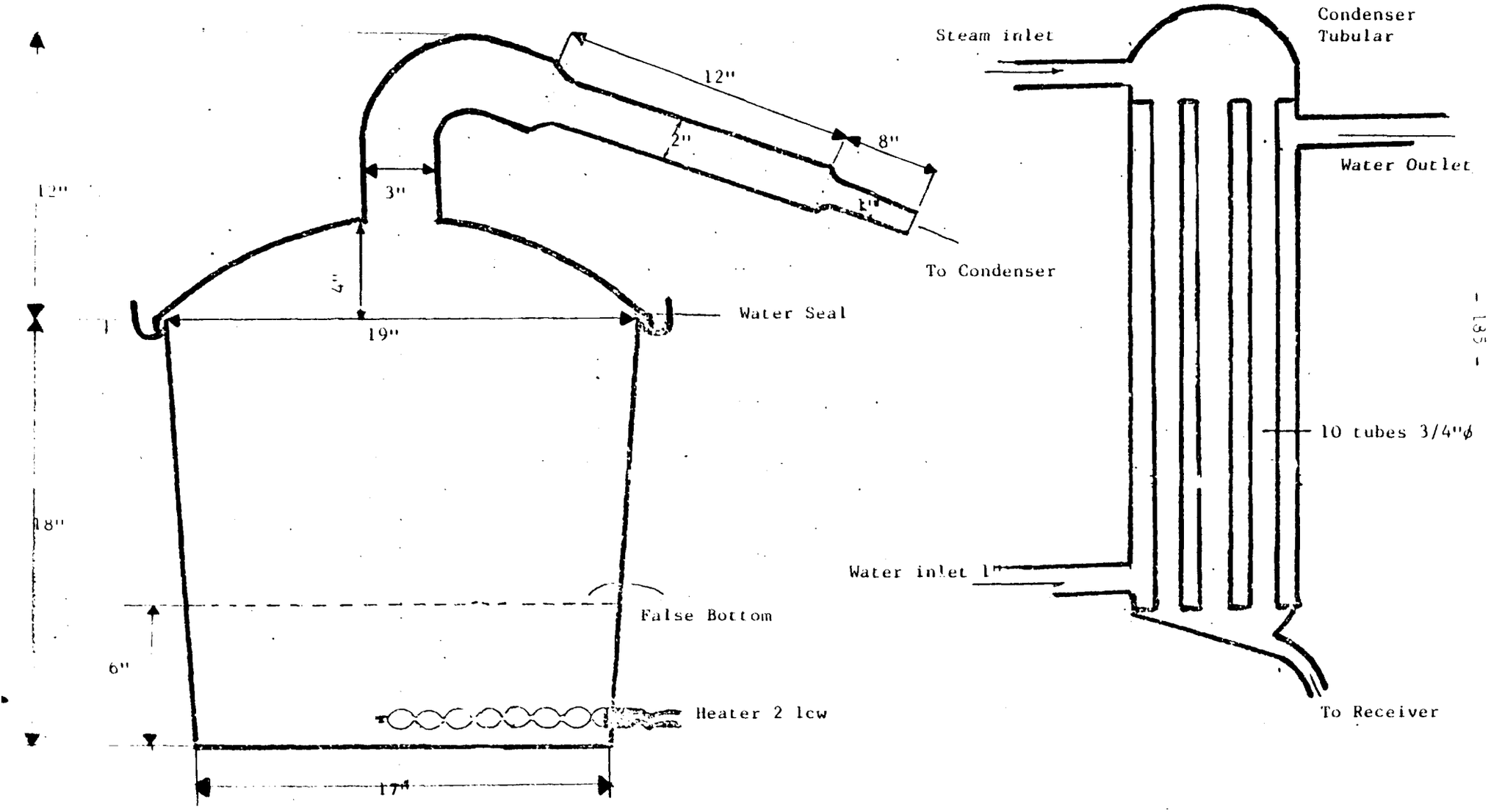


Yield 16-17kg. Pure product (if Eugenol content of oil about 90 percent) or about 15kg (if eugenol content of oil 80 percent).

Annexure XXX

LABORATORY DISTILLATION UNIT

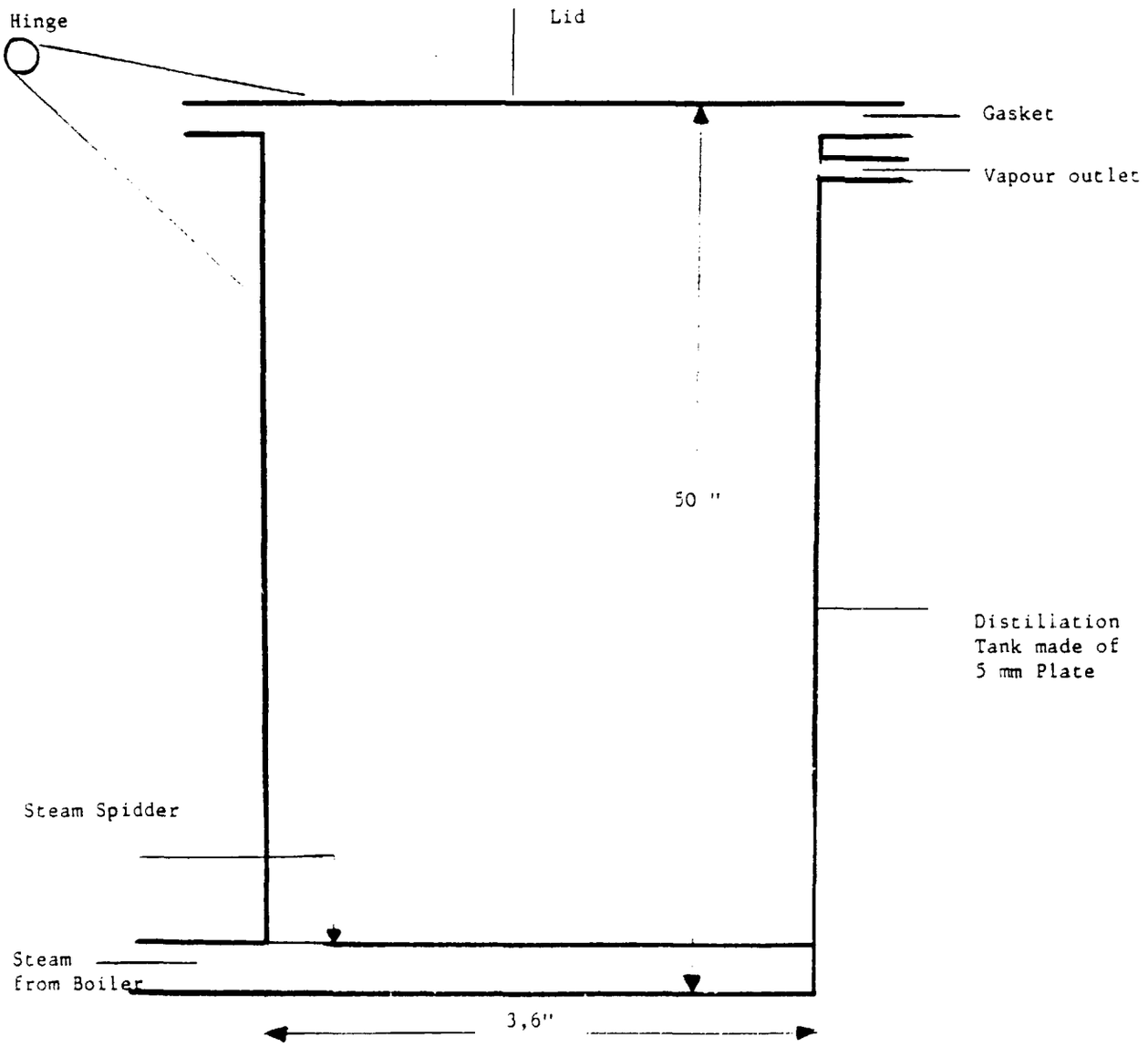
(capacity 75 litres ,Stainless steel or copper)



Annexure XXXI

LINE DIAGRAM OF DISTILLATION UNIT OF 200 KG CAPACITY SUITABLE FOR STEAM

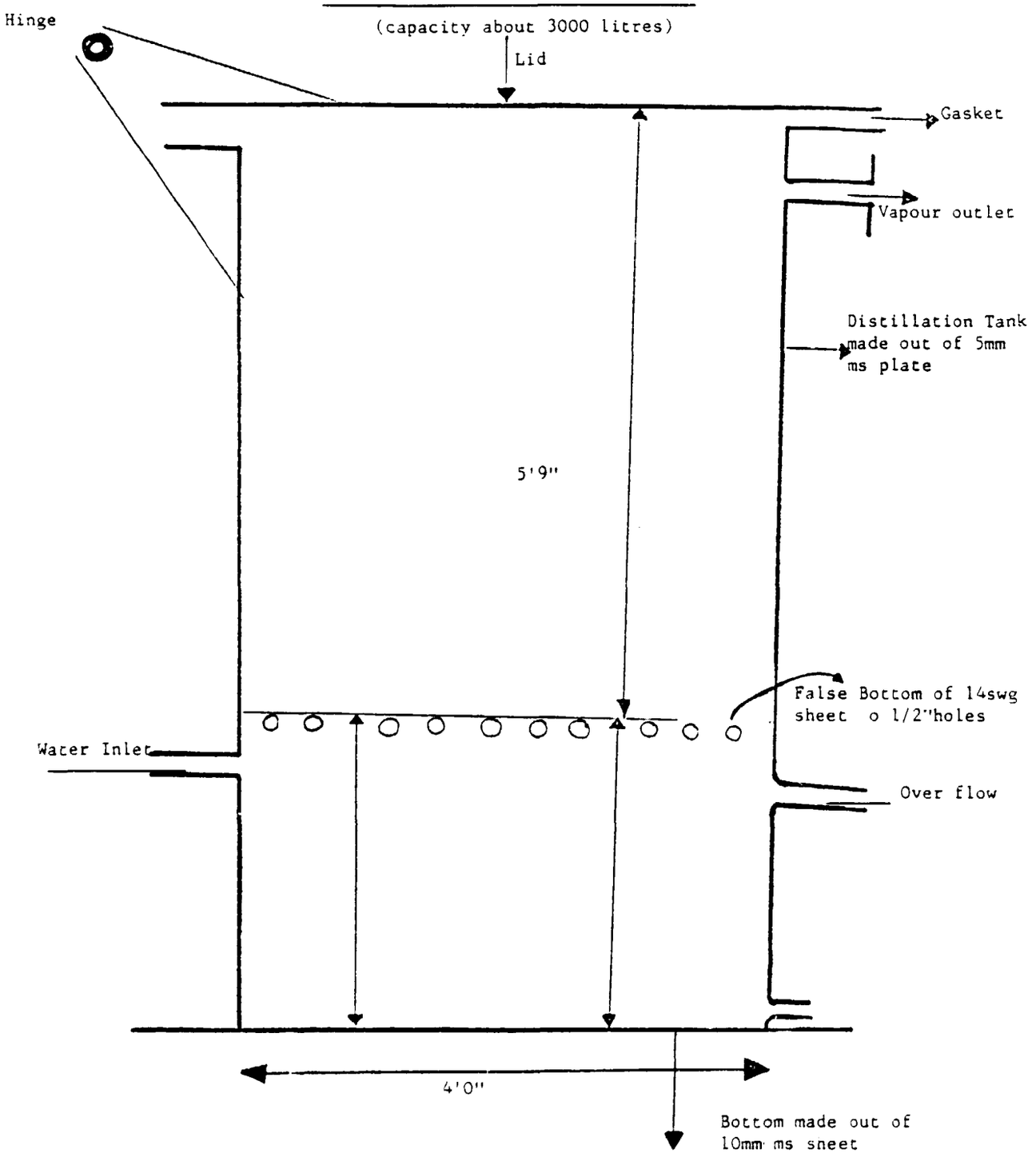
(capacity about 1400 litres)



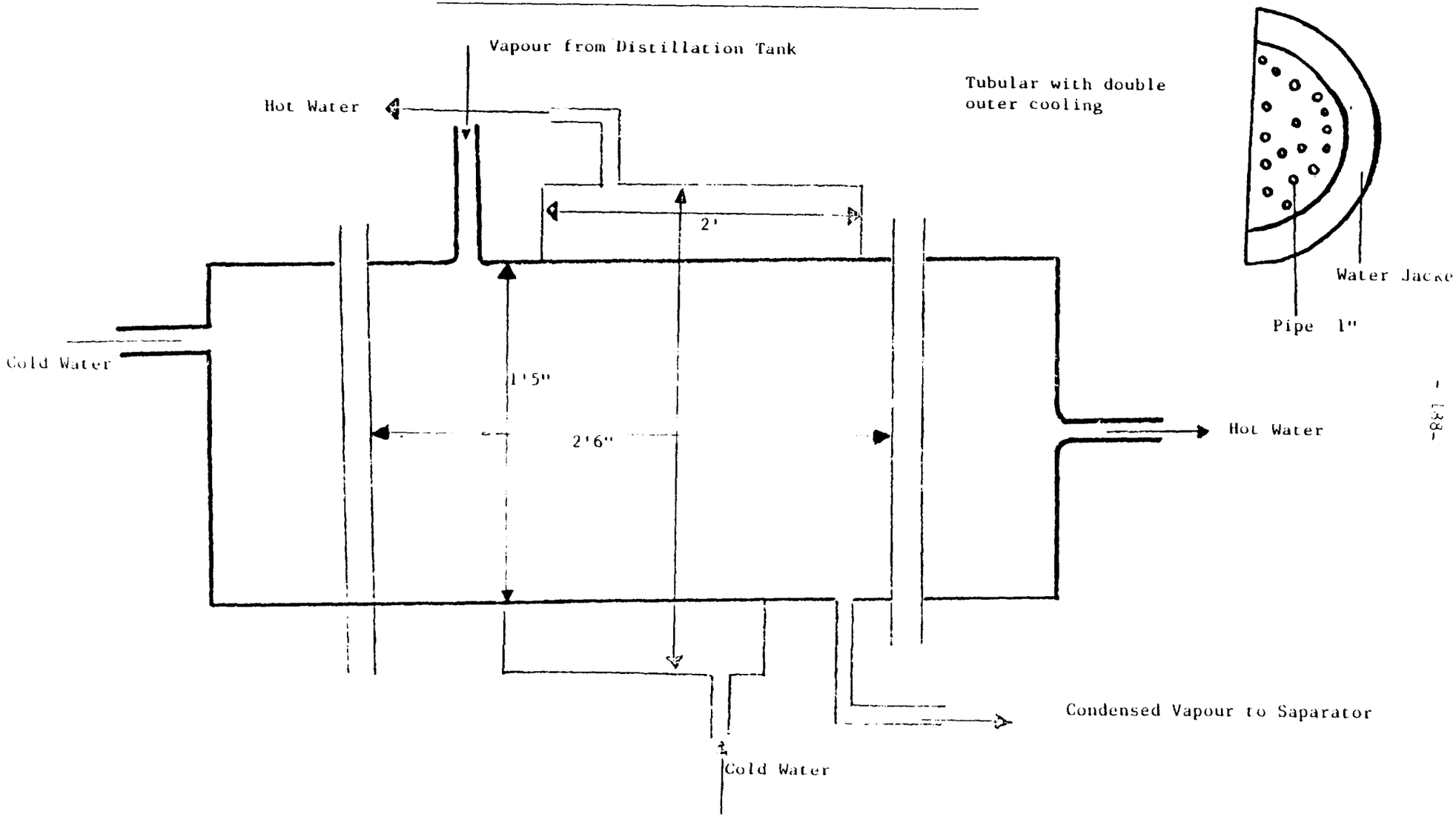
Annexure XXXII

LINE DIAGRAM OF DISTILLATION UNIT OF 300 KG SUITABLE FOR FIRE WOOD SIZE 7'x4'

(capacity about 3000 litres)



LINE DIAGRAM OF CONDENSER



LINE DIAGRAM OF OIL SEPARATOR

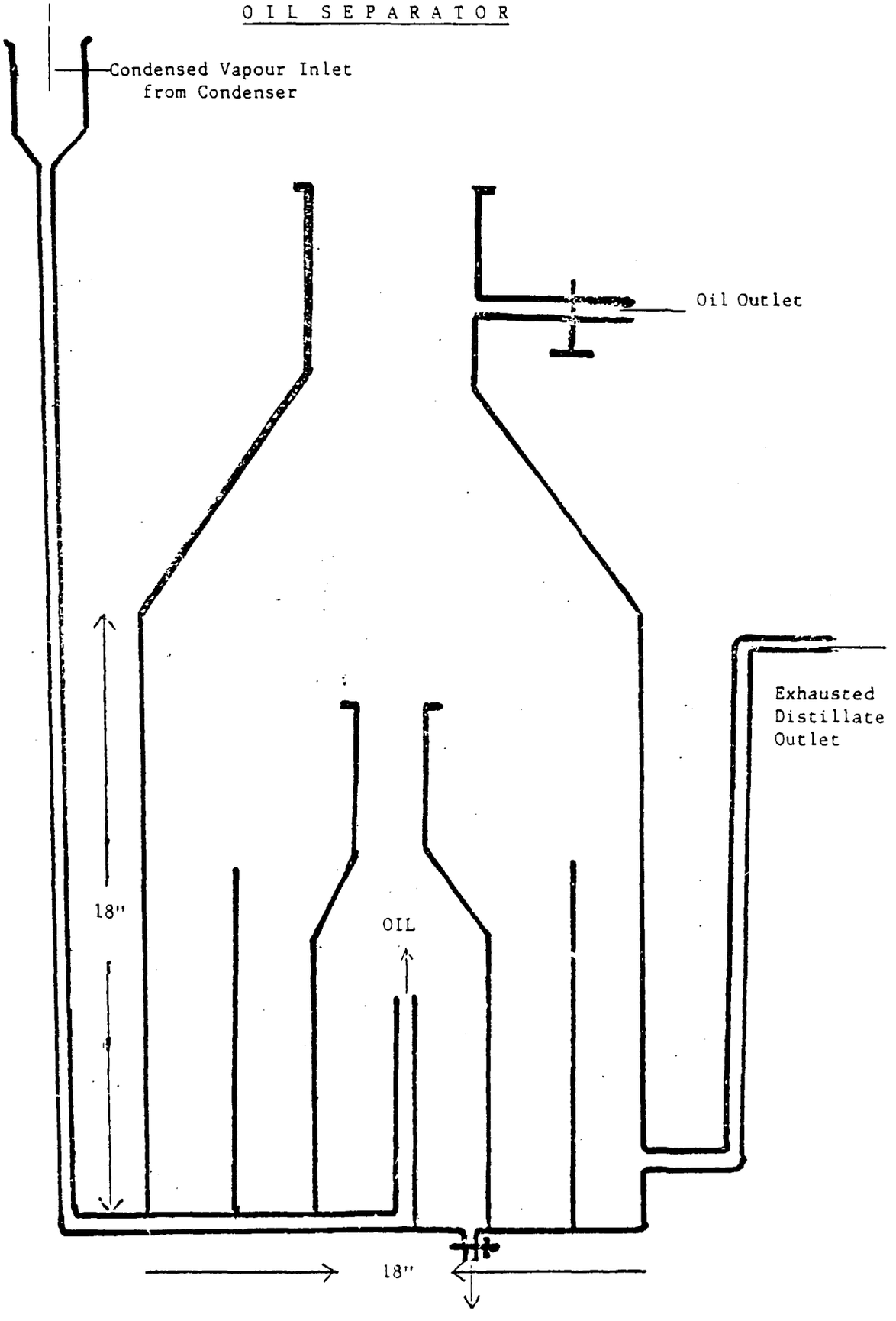
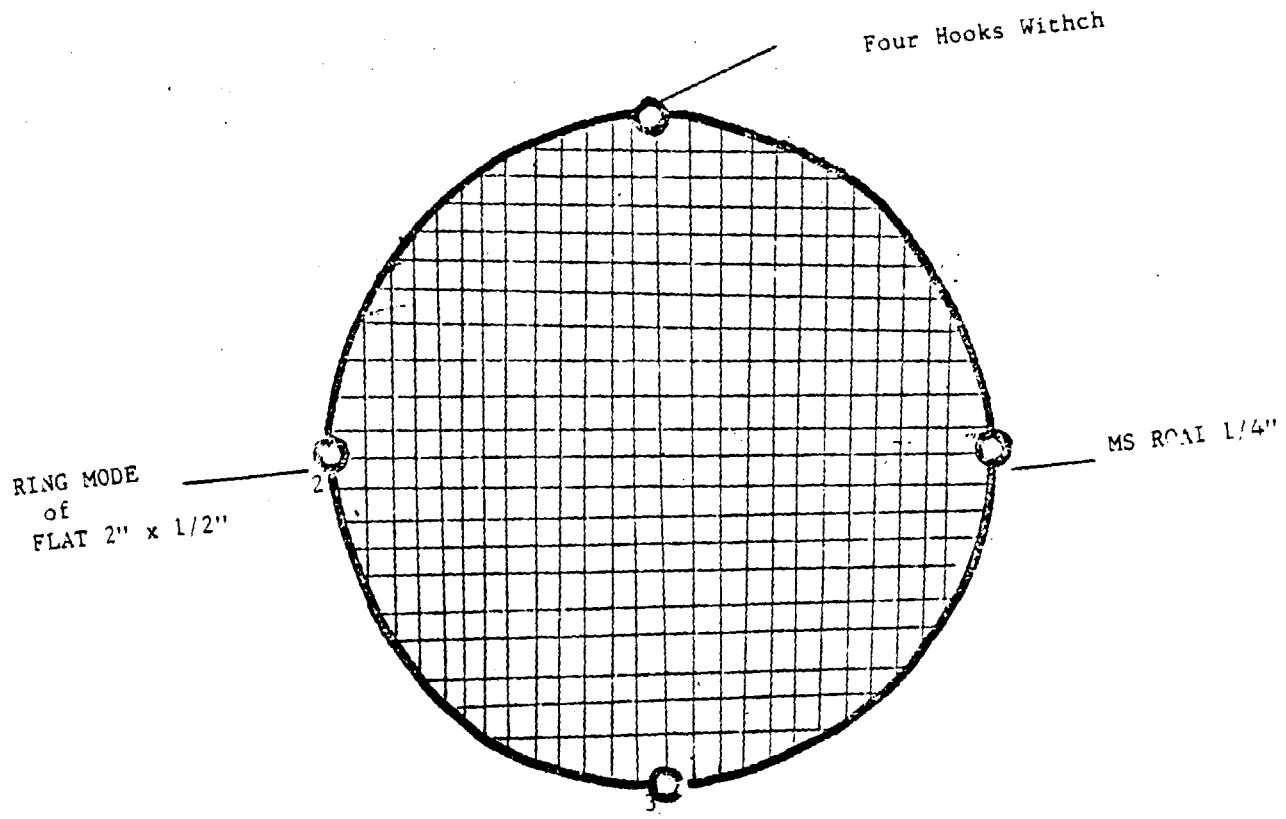
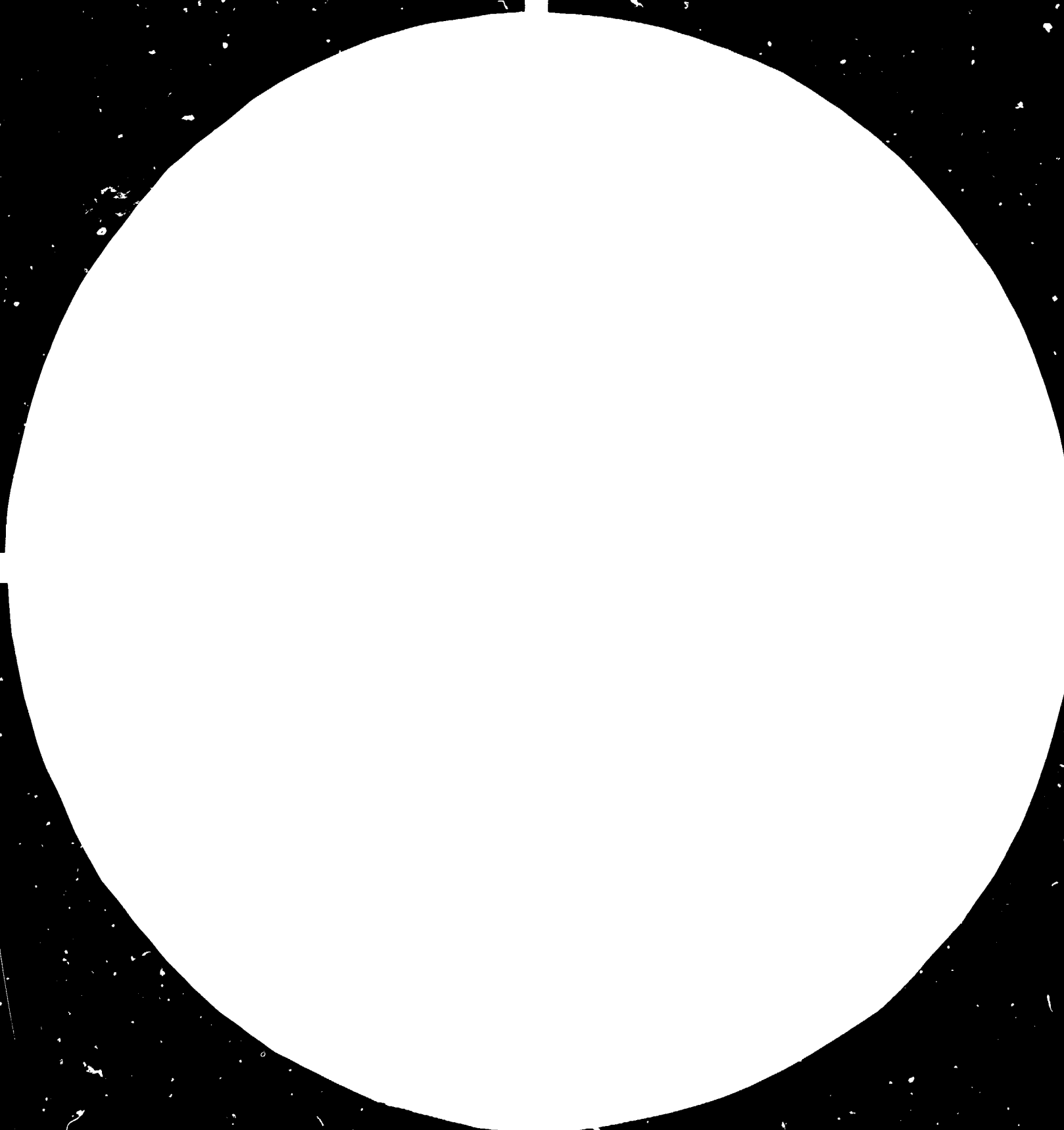
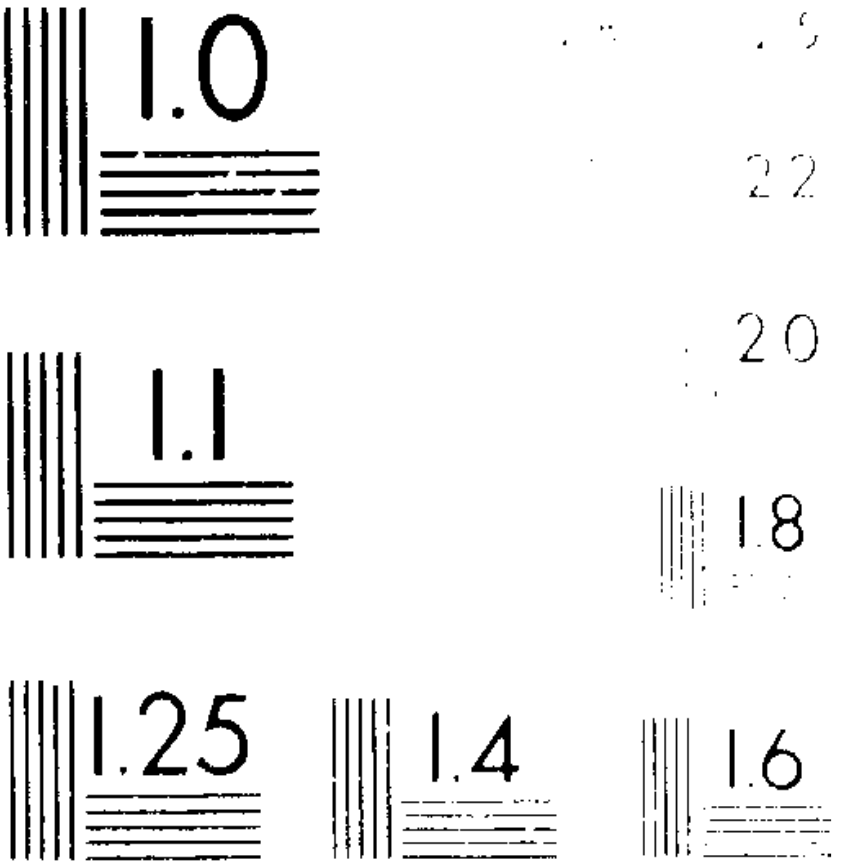


DIAGRAM OF FALSE BOTTOM






1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2

Annexure XXXIII

Traditional Medicines and Role of a Traditional Medicine Practitioner in Zanzibar and Pemba.

Traditional medicines and Traditional medicine practitioners are an integral part of the social and cultural life of the people. Concept of traditional medicinal practitioner (Mjanga) refers to different type of practitioners- e.g.

i) Herbalist (Munya, Migoda, Mukofi)
ii) Diviner and Healer (Mulagusi - Munya, Migoda).
iii) Diviner (Mulagusi - Munya, Misoka).
iv) Diviner, healer and sorcerer (Mukofi, Magaija matego)
v) Sorcerer (Munya metago - Muhavi).

In actual practice it is, however, difficult to differentiate strictly from one practitioner to another. One person may practice as herbalist and diviner and also possess knowledge to practice sorcerery . In the community, people have knowledge of who is who among them and thus know when to refer one to whom. There are maganga who inherit the knowledge and in turn pass on the same to the next generation. Others, however, come suddenly to be under "Possession" and under this state can divine the nature and cause of the illness or problem and also suggest necessary course of action. In the case of natural disease, the 'mganga' can even, at times suggest treatment in a hospital.

Diseases which are divined to have a supernatural cause, e.g. some forms of mental disturbances, general ill health or persistent headache are considered more complicated and often require a ritual with some incisions in different parts of the body of sick person. Diviners who also practice medicine are in majority.

Application by witchcraft is still a strong belief. There is consequently a socially approved practice of using both hospital and the traditional medicine unless 'nganga' puts a restriction.

There is, in general, no definite code of practice and varies from one practitioner to another. Even prayers, advice of general cleanliness, moral value, play a part with some of the nngangas, especially in catholic community.

It is also believed that a good number of illness come out of disturbances in social relationship. Lack of respect (like wearing short dresses) as well as not following party instructions are considered causes of ill health. In nutshell, changes developments in socio-political influence the traditional system of medicine.

It is reported that as many as 71 different diseases are treated and about 400 medicinal herbs are employed in traditional medicine.

The Expert had an occasion to visit 4 different localities in Zanzibar and Pemba. Information obtained on some of the plants and their medicinal uses, as a result of discussion with local traditional medicine practitioners is summarised here under. The local names of the plants are given as described by the practitioners. Botanical names are taken from local floras.

Local Name	Botanical Name	Disease for which used	Method of Administration
Iliki	Elettaria cardamom	Asthma	Root is boiled with ubani and extract taken internally.
Kapok (Msufi)	Ceiba pentandra	Asthma	i) Tender leaves ground with salt, boiled and taken relieves asthama in early stages. ii) Roots of coconut tree mixed with red ubani, boiled and taken. Good for advanced asthma.
Mahareta	Sapindus saponaria	Chronic cough	Leaves boiled with water, decoction taken.
Macho ya ti-pitipi.	Abrus precatorious	Asthma	Leaves ground with water, filtered and extract taken.

Mlangamia	Cassytha filiforms	Stomach troubles	Roots boiled with leaves of Abrus precatorius and decoction taken. Relieves swelling in stomach.
Mbangi wazimu	Ethulia conyzoides	Hernia, Lumbago	Boil roots with water till water becomes coloured. To drink decoction.
Mbono	Jatropha curcas	Bilharzia	Roots boiled with ubani, decoction taken.
Mchamvi	-	Eye diseases, conjuctivites	Leaves boiled with water , decoction used to wash eyes; good for conjuctivities.
Mdimu Lime.	Citrus aurantifolia	Acute stomachache	Boil bark and decoction taken internally.
Mdimu mwitu	Wild growing species of Citrus.	Epilepsy	Leaves ground with water filtered, extract taken for fortnight.
Mhina	Lawsonia inermis	Abdominal pain, dysentry	Roots boiled, with fresh milk of cow and taken.
Mjafari	Erythrina tomentosa	- do -	Roots ground with water, extract taken.
Mkanga jua	Cassia spp.	i) Child birth	Roots boiled with salt, decoction helps in delivery.
		ii) Epilepsy	Leaves boiled in water, person having fits is bathed i in this decoction.

M komamanga	Punica granatuma	Ring worm	Roots cut into 22 pieces; 21 pieces boiled with red ubani and drunk. The 22nd piece cut into 3 pieces and burnt. Ash is ground with roots of Solanum trepidens, rose water added to this mixture which is applied on affected part of body for ring worm.
Mkanmwa	-	Appendicites.	Roots boiled with few grains of rice and decoction taken.
Mkwambe	-	Stomach trouble	Roots boiled with leaves of Abrus precatorius and decoction taken.
Mlaza-laza	-	Pyorrhoea	Mixed with bark of mango tree and used.
Mlangamia	Cassia piliformis	Swelling in stomach.	Tubers of mlangamia boiled with roots of mkwamba. Decoction taken.
Mnazi	Cocos nucifera.	i) Gonorrhoea	Boil the roots & decoction taken.
		ii) Bilharzia and iii) Asthma	Boil roots with red ubani and decoction taken.
Mpapai	Carica papaya	Gonorrhoea	Root decoction taken
Mpenda pendapo	Canthium zanzibaricum	i) Child birth	Roots boiled with red ubani and decoction taken.
		ii) Skin diseases and ringworm.	Berries ground with coconut oil. Paste applied on skin.

		iii) Bilharzia	Berries boiled with ubani and decoction taken
		iv) Dysentry	Leaves with fresh clove leaves and ubani are boiled. Decoction used.
Mpera	Psidium guajava	Eye infections conjuctivities	Leaves boiled with red ubani and eyes exposed to vapours .
Mronge	Moringa oleifera	Skin diseases	Roots or bark ground with coconut oil. Paste applied.
Mshubiri mwitu	Aloe kirkii	Hydrocyl.	Boil root with red ubani Decoction taken.
Msoo	Caesalpinia crista	i) Cataract	Nut ground with water. Extract put in the eyes.
		ii) Diarrhoea, Stomachache	Root decoction used
		iii) Delayed labour pains	Root pieces boiled with ubani and taken (decoction.)
Mbago	-	Epilepsy	Leaves with leaves of 'mbuyu kuku' burnt. smoke inhaled.
Mtonga	Xylocarpus benadirensis	Eczema	Bark burnt and paste made with coconut oil for use on eczema.
Mumbuzi	-	Convulsion fevers	Grind leaves with water and apply on whole body.

Mnuka mavi	-	i)Ulcer	Root decoction taken
		ii) Chronic wounds	Paste of root with oil applied.
Mvumo dume	-	Eczema, ring worm.	Powdered ash with coconut oil applied on affected part of skin.
Mwache	-	Child birth	Root boiled with salt. Decoction taken for ease in child birth.
Mwavi	Erythophyllum guineense	Eczema	Used with bark of Mtonga, ash made into paste with coconut oil and applied.
Mwembe	Mangifera indica	i) Yaws	Boil bark with salt, inhale steam vapours.
		ii) Pyorrhoea	Mixed with mlaza laza, salt and water and taken.
Mweusha	-	Gastric troubles	Boil root with clove. Decoction taken.
Utupa wa kibaazi	Tephrosia vogelii	Impotency	Roots boiled with chillies and decoction taken for 5 days.
Wani uvage	-	Headache	Decoction of leaves with salt taken.
Weni	Tragia spp.	Asthma	Roots boiled with Canthium zanzabaricum and ubani, Decoction taken thrice a day for 3 days.

PROJECT PROPOSAL

PART A - BASIC DATA

COUNTRY	:	ZANZIBAR
PROJECT NUMBER	:	
PROJECT TITLE	:	Assistance to the Zanzibar Pharmaceutical and Essential Oil Industry : Production of Essential oils from natural and introduced resources, evaluation of essential oil bearing material and products utiiisation in Pharmaceutical, Frangrance and Flavour Industries both for indigenous use and export
SCHEDULED START	:	1985
SCHEDUCLED COMPLETION	:	1987
ORIGINAL AND DATE OF OFFICIAL REQUEST	:	
GOVERNMENT COUNTERPART AGENCY	:	Ministry of Health and Social Welfare, Zanzibar
UNIDO CONTRIBUTION	:	US$ 179.400
GOVERNMENT CONTRIBUTION	:	
CURRENCY REQUIRED FOR UNIDO INPUT	:	
CONVERTIBLE	:	
OTHER	:	
UNIDO SUBSTANTIVE BACKSTOPPING SECTION	:	Chemical Industries Branch Pharmaceutical Industries Unit
PROGRAMME COMPONENT CODE	:	32.1.D

PART II - NARRATIVE

1. BACKGROUND AND JUSTIFICATION

UNIDO, as a follow up of the findings of the Mobile Unit under the auspices of UNIDO - Roumania Centre (Project RP/RAF/79/005) in their preliminary survey of the natural resources of the Islands, undertook an evaluation study of the essential oils bearing plant material resources, both cultivated and natural under the Project URT/82/803. This study has indicated positive potential of economic utilisation of a number of essential oil bearing plants such as bye-products of clove tree, essential oils of cardamom, cinnamon bark and leaf, camphor leaf, ginger and chillie products, lemongrass and oils from plants that have promise of cultivation such as dill (anethi) coriander, aniseed, caraway, Mentha species, citronella etc. Oils produced from some of the available materials on pilot scale were found to be of acceptable quality.

The essential oils that could be produced now and in the near future would contribute a great deal towards the Pharmaceutical and Essential Oils Industry both indigenous as also for export.

The Government of Zanzibar is keen to implement the recommendations of the Expert based on his work in the Island under Project URT/82/803.

2. SPECIAL CONSIDERATIONS

Zanzibar and Pemba, popularly known as 'Spice Islands' and famous for its cloves and clove stem oil have unfortunately, lost much of its trade in these items due to combination of various factors. However, it has now established a Pharmaceutical Industry with considerable help from UNIDO involving large investment both in men and material. Production of essential oils for pharmaceuticals can help revive essential oil industry in general and production of high value low volume items in particular which will boost the economy of the Islands. Help is needed

only in the utilisation of its resources as investment in distillation facilities has already been made both in Zanzibar and Pemba.

3. OBJECTIVES

a) Development Objectives:

To strengthen the pharmaceutical and essential oil industry based on local and introduced materials and thereby give an overall boost to the essential oil industry for export which together will not only save foreign exchange but also earn the much needed foreign exchange.

b) Immediate Objective:

Results obtained under Project URT/82/803 in the laboratory and pilot scale production of essential oils from local resources need to be translated into commercial production of the selected essential oils for utilising in the indigenous pharmaceutical industry and for export; utilization of even a part of the clove leaves available (from dead trees, broken branches and those which fall down naturally) can contribute about US $ 1.6 million to 2.0 million per annum.

4. PROJECT OUTPUT

During the first part of the project - 6 months - the Expert will produce essential oils and products from the plants already identified, assess their quality, economics of production and utilisation in local industry. He will, with the help of local personnels assess the overall availability of essential oil bearing plant materials for establishing a viable production unit.

During the second part of the mission - 6 months, portable distillation units will be installed in 2 selected areas to initiate production trials of materials like clove leaf and Ylang Ylang. Clove leaf oil will be further processed on large scale into value added

products, upgrading of oils by rectification will also be taken up.

5. PROJECT ACTIVITIES

- Nomination of national project personnel
- Identification, selection and fielding of the international expert.
- Production of essential oils on large scale both in the existing distillation units and in the portable units in selected areas.
- Training local personnels to handle all aspects of large scale production.
- Work out economics of production, help in optimum utilisation of production facilities.
- Submission of report for the consideration of the Government to take up regular production.

6. INPUTS

- UNIDO inputs
- Essential Oils/Pharmaceutical expert 12 months, split mission 6 m/m.
- Laboratory chemicals, apparatus, equipment.
- Distillation units (Portable and Pilot scale)

Government inputs:

- National personnels as required and counterpart to UNIDO Expert.
- Laboratory space, office, secretarial, administrative and transport facilities.

7. EVALUATION PLANS

The final report of the Expert will be evaluated by the Pharmaceutical industries Unit of UNIDO.

8. Envisaged Follow-up:

It is expected that after this Mission, the Government of Zanzibar will be in a position to take up industrial production, quality control, analysis and upgrading of the products where required.

PART III - PROJECT BUDGET

Budgetline	11-00	Experts		
	11-01	Pharmaceutical Adviser and Essential Oil Expert 2 x 6 m/m split mission	US$	107.400
	41	Expendable equipment for Laboratory....	US$	25.000
	42	Non-expendable equipment (to be fabricated)		
		Portable Distillation Units for Field Use (capacity:500 kg) 2 units	US$	25.000
		Laboratory Scale Distillation Units	US$	15.000
	31-00	Training - 2 fellowships for local personnel	US$	7.000
		GRAND TOTAL:	US$	179.400