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MAXIMIZING THE CAPACITY OF THE CLOVE DISTILLERY AT CHAKE CHAKE, PEMBA

DP/URT/86/026

TANZANIA

Technical report: First mission*

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

Based on the work of Mohan L. Maheshwari,
quality control chemist

Backstopping officer: R.O.B. Wijesekera,
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Vienna

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ABSTRACT

Dr. Mohan Lal Maheshwari, Quality Control Chemist in the project "Maximising the capacity of the clove distillery at Chake Chake, Pemba, United Republic of Tanzania, No.DP/URT/86/026/11-54/J 13422" took up his first phase of assignment for two weeks (August 3-16, 1989). He was briefed by C.T.A. and Programme Officer, UNIDO, at Dar-es-salaam and had discussions with Deputy G.M., ZSTC and Plant Manager at Chake Chake about the project.

Based on UNIDO programmes of the project, a design and layout plan of self sufficient laboratory has been prepared and same explained to the Manager of distillery. Lists of equipments, chemicals, glasswares and miscellaneous items required for quality evaluation of essential oils have been drawn.

Appointment of qualified chemist and his training needs have been suggested. Training in maintenance of Gas Chromatograph and its trouble shooting has been advised for Production Manager, who has electronic background.

Clove bud and stem oils were examined for their odour. Locally growing aromatic plants of lemongrass, vetiver, Cinnamon, Ocimum Sps. and Artemisia were distilled and their essential oils were examined for aroma pattern for future use.

RECOMMENDATIONS

In order to make best use of the project following recommendations are made from Quality Control point of view:

1. Instrumentation rooms for housing Gas Chromatograph, Refractometer, Polarimeter and Balances and Gas cylinders cabin for hydrogen, nitrogen, and zero-air cylinders should be created immediately as per design. Instrumentation rooms should be furnished with requisite furniture and electric points as shown in design.

2. Chemical laboratory should be equipped with additional lab. benches, electric points, sinks etc. All benches should be provided with drawers, cupboards, shelves etc.

3. A room adjacent to Chemical lab. (eastern side) should be converted into a store room for glasswares, chemicals etc. and be furnished with shelves.

4. A qualified chemist should be appointed immediately so that he can be sent for training to acquire knowledge in the related field and is ready to practice the analytical techniques.

5. Production Manager should be sent for training to the Gas Chromatograph supplier to acquire the knowledge of exact installation, trouble shooting, normal functioning of instrument etc.

6. Distillery should take steps to procure 200 litres of rectified spirit per annum for analysis purpose.

7. All equipments, chemicals, glasswares, miscellaneous items should be procured as early as possible.

8. Z.S.T.C. should develop specifications for their clove stem and bud oils to meet ISO, EOA, BS, BIS, BP specifications, which will generate more confidence among users.

9. Cultivation and distillation of locally available materials like - vetiver, lemongrass, Cinnamomum, and Ocimum sps. may be taken up as diversification.

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INTRODUCTION

The project "Maximising the capacity of the clove distillery at Chake Chake, Pemba, United Republic of Tanzania", No.DP/URT/86/026/11 - 54/J 13422 was joined by Dr. Mohan Lal Maheshwari, Quality Control Chemist on August 7, 1989 at Chake Chake. Briefing was done by Dr. Baldev C. Gulati, C.T.A. and Mr. J. Rasmussen, Programme Officer UNIDO/UNDP, in UNDP office, Dar-es-Salaam on August 4, 1989. Quality Control Chemist (Q.C.C.) could not arrive in Chake Chake during the presence of C.T.A., as his earlier programme of arrival on July 13, 1989 was postponed by a cable received by him from UNIDO Vienna, about postponing his programme. Q.C.C. could not arrive at site on August 5 due to cancellation of flight from Dar-es-Salaam to Pemba on August 5. He arrived on August 7, 1989 on the site in Chake Chake by next available flight alongwith Agronomical expert in the project, Dr.K. Dürbeck.

Q.C.C. had discussions with Deputy General Manager, Zanzibar State Trading Corporation (Z.S.T.C.) Mr. Hamad Khamis Hamad, former Dy. G.M. (Z.S.T.C.) Mr. Hakum Said Sanani and Admin. Officer (Z.S.T.C.) Mr. Sadra Hassan Juma about the project at Chake Chake.

Detailed discussions were held with Plant Manager, Mr. Nasib S. Omar and Production Manager, Mr. Ramadhani K. Feruzi of Clove Stem Distillery in general and about quality control in particular. They had taken Q.C.C. around the distilling facility and existing chemical laboratory. Salient features on the work done according to Job Description (Annexure-I) during first phase (two weeks - August 3 - August 16, 1989) of the mission of the Q.C.C. are given in the following pages.

1. Design and layout of quality control laboratory

At present laboratory distillation and chemical analysis are carried out in a room (23' 8" x 24' 6"). After seeing the requirements and the space available, a drawing, showing design of Instrumentation room with airconditioner and dehumidifier for Gas Chromotograph; Balance room for balances, polarimeter and refractometer; a room for keeping spares for instruments and a small cabin for keeping three cylinders (Nitrogen, Hydrogen, Zero air) has been designed as shown in drawing enclosed (Annexure-II). Modification in chemical laboratory has also been suggested with respect to additional lab. tables, sinks, electrical points, drawers and shelves in existing and new tables. Design of tables with drawers for intrumentation room, balance room and spares room and positions of electrical points have been shown in the drawing.

A room (19' 2" x 9' 8") adjacent to Chemical laboratory (east) has been suggested to convert it into a store room to store glaswares, chemicals and miscellaneous items.

The distillery has been requested to take up modification and furnishing work immediately, so that equipments, glasswares, chemicals can be installed/put in proper positions and work may start immediately.

2. Equipments

At present laboratory is not adequately equipped to meet its future requirements. A few equipments, available, are not in working order and some are worn out. Hence, a comprehensive list of equipments has been prepared as given in Annexure-III. These equipments will meet all the requirements of the quality evaluation of essential oils produced at present in the distillery and essential oils proposed for future diversification. It was informed by C.T.A. that Gas Chromatograph, its spares, Nitrogen, Zero-air, Hydrogen cylinders and accessories are already being processed by UNIDO, hence not included.

3. Chemicals

Availability of chemicals is almost nil at present in the laboratory. In view of meeting requirements of chemical analysis, a list of chemicals has been drawn up as shown in Annexure-IV. This will meet most of the requirements of quality analysis of essential oils. The chemical analysis of essential oils requires large amount of 95% ethyl alcohol (rectified spirit), arrangements may be made by Z.S.T.C. to procure 200 litres of rectified spirit annually.

4. Glasswares

There are few glasswares in the laboratory, therefore laboratory requires all the essential glasswares needed for essential oil analysis. A list has been prepared and shown in Annexure-V. This will make quality control laboratory self-sufficient for chemical analysis of essential oils.

5. Miscellaneous items

Most of the miscellaneous items and hard wares like stands, clamps, bossheads, ring clamps etc. are not available in the laboratory. A list of various items has been drawn as shown in Annexure-VI.

Some of these lists may appear exhaustive but these have been prepared by keeping location of Pemba Island in mind and absence of adequate facilities of glass blowing and chemicals even on mainland in Tanzania.

6. Development of management system, manpower requirements and training needs

A. At present there is only one Lab. Attendant in Chemical Lab., therefore, there is an urgent need to appoint a qualified chemist, who has an inclination to work with aroma chemicals. He should then be sent for training for a period of three months in reputed Institutes like Central Institute of Medicinal & Aromatic Plants, Lucknow, India; Regional Research Laboratory, Jammu, India etc. Finally after his training he can spend two weeks with expert (Q.C.C.) at National Bureau of Plant Genetic Resources, New Delhi, India. After this training on his return to Chake Chake, he can set up all the basic items required for chemical analysis of essential oils; so that he is ready to practice the quality control techniques when project expert (Q.C.C.) arrives at site.

B. Gas chromatograph is the heart of analytical techniques used in essential oil analysis and it is very important to maintain and keep it in running form. Maintenance service will not be available on this Island. It is, therefore, strongly recommended that qualified engineer like Production Manager, who has his background in electronics, should be sent for training to Gas chromatograph supplier. There, he should learn basic things about instrument and its components, initial installation of equipment, i.e. making connection of gases, electrical connections, start up operations, % calculations; trouble shooting, identification of faults with P C Bs and other electrical/mechanical components. This training will require 4-weeks time, but this will be highly beneficial for the distillery for keeping GC instrument in working order for years to come.

7. Quality of clove stem & bud oil and oils from local aromatic plants

A. **Clove stem oil:** This distillery mainly produces 250-300 Kg stem oil in one shift. The oil is very clear and slightly yellowish in colour. Leaf oils from other countries are highly coloured (brown to dark brown). On examining last two years data, it shows that they are getting uniform quality of stem oil having 91-93% eugenol (chemically). Q.C.C. observed that stem oil is distinctly pungent, characteristic of eugenol.

B. **Clove bud oil:** This distillery also produces bud oil once in a while. Bud oil is also very clear and slightly yellow in colour. It was observed that bud oil has a very round note of clove with a distinct fruity odour.

Q.C.C. was told that these oils meet I S O specifications. It is recommended that Z.S.T.C. should develop specifications for these two oils, which can cover up I S O, E O A, B S, B I S and others. This will be very helpful in sales promotion and quality conscious people will have more faith in the products.

C. Q.C.C. also examined the oils of wild growing plants distilled during stay of C.T.A. and Q.C.C. Observations based on odour evaluation are given below:

(i) **Vetiver oil:** Vetiver growing wild on the Island gave 0.8% oil from roots. The oil is clear and unusually colourless. The oil has woody earthy and slightly balsamic aroma, which resembles to those from Reunion and Haiti.

(ii) **Lemongrass oil:** Locally growing material gave 0.4% oil. It has very pleasant odour, no sharpness and indicating to be rich in citral.

(iii) Ocimum spp : Pemba Island has several types of Ocimum, growing wild. Four types of oils from different materials were examined by Q.C.C.

(a) O.canum/O.grattissimum (?): Its oil gave top notes of β-ocimene followed by eugenolic and caryophyllenic odours.

(b) O.suave (?): This plant locally called as "KIVUMBASI" gave an oil showing herbal and camphoraceous odour of long lasting type. This may find use in perfumery formulations for shampooes etc.

(c) O.sps. : With reddish inflorescence locally called "MREHANI" gave an oil having initial note of methyl-chavicol followed by herbal and then pleasant flowery note.

(d) O.sps. : With purple flower and sticky leaves gave an oil, having herbal, earthy note followed by sweet odour.

(e) Cinnamomum sps. gave 1.2% oil with typical cinnamic odour.

(iv) Artenisia sp. With high fragrance gave 0.85% of blue oil of interesting type.

Among the oils examined vetiver, lemongrass, Cinnamomum sps. and Ocimum sps. locally known as "KIVUMBASI" and "MREHANI" may have good fucure.

CONCLUSION

Quality Control Chemist in his first phase of assignment for two weeks has completed few of the job requirements like - design and layout of quality control laboratory; preparation of lists of equipments, chemicals, glasswares and miscellaneous items; manpower requirements and training needs. He has also examined the preliminary aroma pattern of oils produced in the distillery and those of distilled from locally growing aromatic plants on Pemba Island.

Annexure I

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

11- 54

JOB DESCRIPTION

Quality Control Chemist

Post title	2.5m/m
Duration	1990
Date required	Chake Chake, Pemba
Duty station	**Maximising the capacity of the Clove Distillery Chake Chake**
Purpose of project	**The expert's main duty will be the establishment of a modern laboratory for evaluation and grading of crops of essential oil bearing plants especially clove buds and stems and establishing methods for quality control, standardisation and certification of manufactured products, such as essential oils.**
Duties	**Specifically the expert will be responsible for:** - **Design and layout of a small quality control laboratory;** - **Installation, start-up and operation of instruments;** - **Compilation of manuals of operating instructions and routines for maintenance for instruments;** - **Development of standard test procedures and specifications for products, such as clove oils;** - **Estimation of manpower requirements and training needs;** - **Development of management systems and estimation of operational need.** **After the end of the mission the expert will be required to present to UNIDO a fully prepared report embodying his findings and recommendations.**

Applications and communications regarding this Job Description should be sent to:

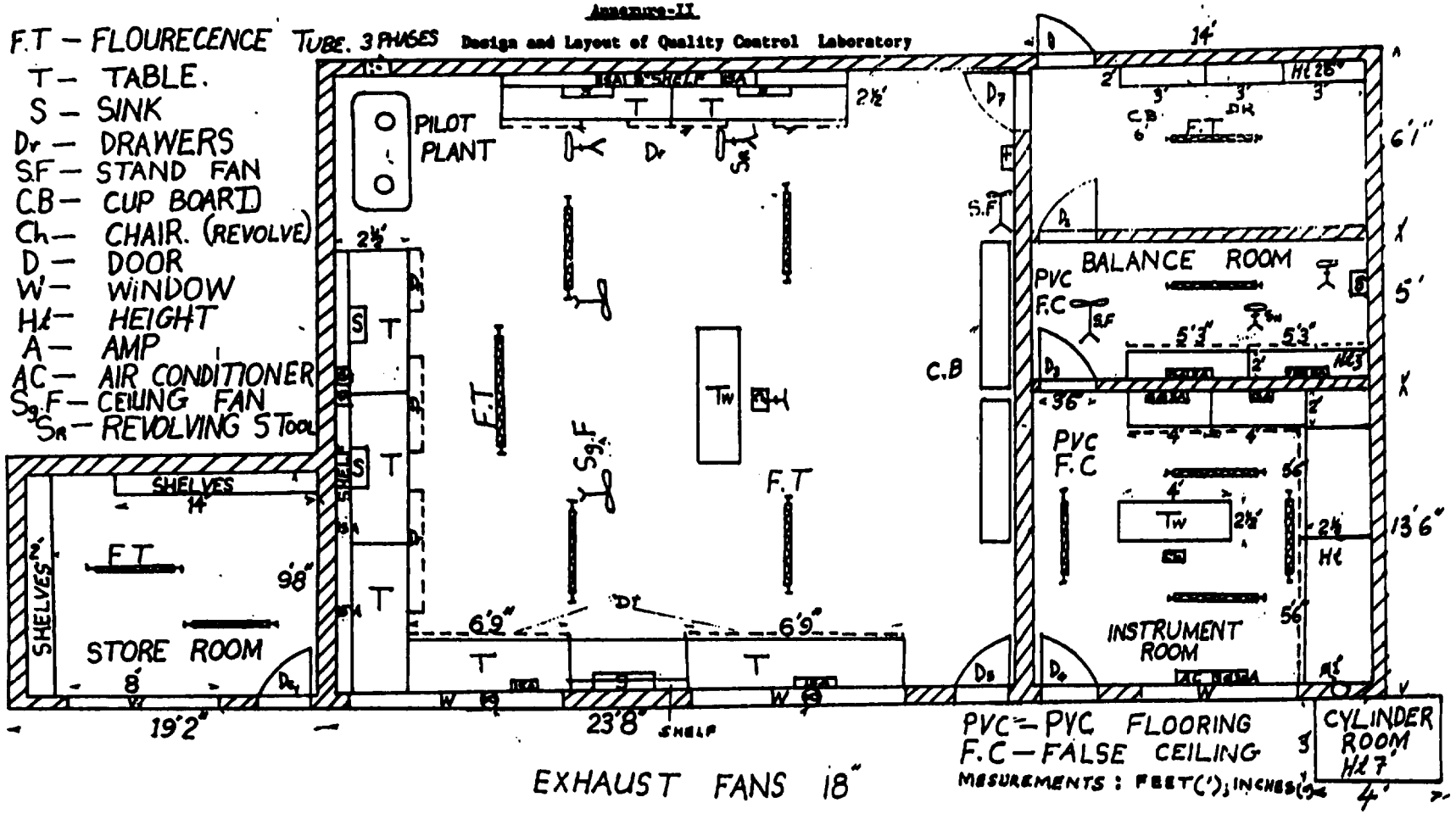
Project Personnel Recruitment Section, Industrial Operations Division
UNIDO, VIENNA INTERNATIONAL CENTRE, P.O. Box 300, Vienna, Austria

Qualifications	Holder of a doctorate in Chemistry or equivalent with considerable experience in compositional analysis and quality standards pertaining to Essential Oils. Experience of working in a developing country an added qualification.
Language	English
Background information	Cloves (Eugenia caryophyllata) are the major crop in the Zanzibar Islands, which include Unguja and Pemba and are traditionally called the Clove Islands. There are two major facilities for the distillation of clove buds and clove stem under the control of the Zanzibar State Trading Company (ZSTC). One is an almost obsolete plant, nevertheless with a considerable production capacity situated at Malindi in Unguja Island. The other is a modern plant at Chake Chake in Pemba Island. In Pemba there is an established capacity but ensurement of maintenance is important. Atuned to the distillation capacity of the plants the ensurement of timely collection and organized drying of raw materials is crucial. The Government expects UNIDO to provide support to enhance the economic, commercial and technological structure to modernise the industry in Zanzibar.

Annexure-II

Design and Layout of Quality Control Laboratory

F.T – FLOURECENCE TUBE. 3 PHASES
T – TABLE.
S – SINK
Dr – DRAWERS
S.F – STAND FAN
C.B – CUP BOARD
Ch – CHAIR. (REVOLVE)
D – DOOR
W – WINDOW
Ht – HEIGHT
A – AMP
AC – AIR CONDITIONER
Sg.F – CEILING FAN
Sr – REVOLVING STOOL



EXHAUST FANS 18"

Annexure - III

List of Equipments

S.No.	Name	Specifications	Quantity	Price($)
1.	(a)	Abbe - Refractometer - With thermometer, arrangements for water circulation and one spare thermometer	One	2,000.00
	(b)	Light source - Philips 250 Watts, 220 volts with holder, stand, wire, switch etc.		
	(c)	Compact Refrigerated thermostat water bath (Temp. 5° - 50°C) with circulation arrangement		
2.	Polarimeter:	0° - 360° with sodium-D-Line with monochromator	One	2,000.00
	Spares: (i)	Sodium vapour lamp	One	
	(ii)	100 mm sample tubes	Two	
	(iii)	50 mm sample tubes	Two	
	(iv)	25 mm sample tube	One	
	(v)	Window glasses for sample tubes	20	
	(vi)	Washers for sample tubes	12	
3.	Mettler balance - Analytical AE - 100 Readability 0.1 mg ; weighing range 0-109 g Taring range 0-109g, Reproducibility 0.1 mg		One	2,500.00
4.	Mettler balance - Top loading PM-4000 Readability 0.01 g,weighing range 0-4100 g, Taring range 0-4100 g, reproducibility 0.01 g		One	2,100.00
5.	Airconditioner 1.5 ton, 13,000 BTU /Hr Hitachi - RA - 3141B with 4 KVA voltage Stabiliser with time delay device 220 volts/50 cycles		One	600.00
6.	Dehumidifier - "Munters - Model M-120" Process air; 120m^3/h; Reactivation air flow 35m^3/h 1.3 KW, 220 volts/50 cycles		One	1,000.00
7.	Laboratory oven: Dimensions 35x35x35 cm(Inner) Temperature range 5°C above ambient to 180°C, with L shape thermometer, 0.75 KW 220 volts/50 cycles		One	250.00
8.	Mechanical Stirrer (electrical) 1/20 H.P. 4000 RPM, with speed control of continuous type and S.S. and glass shafts with teflon propellers 220 v/50 cycles, 0.6 Amp.		One	400.00

S.No.	Name	Specifications	Quantity	Price($)
9.	Melting Point apparatus - Büchi (Swiss)	heating in steps, mineral oil bath, stirrer and capillaries (200), Ac220 volts/50 cycles	One	500.00
10.	Refrigerator with freezer compartment	capacity 360 litres with voltage stabiliser, AC 220 volts/50 cycles	One	500.00
11.	Drying cabinet with racks, forced air	circulation, Dimensions: 525(H), 760 (W), 335 (D) mm, AC 220 volts/50 cycles	One	300.00
12.	Water bath - stainless steel, 6-holes	with concentric rings (7.5 cm dia); dimension 35x25x10 cm, Thermostat control (energy regulator),constant level device and automatic cut out; 1KW, 220 volts.	One	200.00
13.	Water bath circular stainless steel, dimensions:	25 cm (Dia) x 14 cm (Ht), with concentric rings, thermostatic control with energy regulator, constant level device and automatic cutout 1 KW, 220 volts.	One	100.00
14.	Water bath circular S.S. dimensions:	32.5 cm (Dia) x 16 cm (Ht) with concentric rings, thermostatic control with energy regulator, constant level device and automatic cutout 1.5 KW, 220 volts.	One	120.00
15.	Heating Mantles:			
	(i)	50-250 ml built in energy regulator pilot lamp, 120 watt, 220 volts	One	40.00
	(ii)	1 - litre built in energy regulator, pilot lamp, 300 watt, 220 volts	Two	120.00
	(iii)	5 - litre, built in energy regulator, pilot lamp, two circuits (2 x 300 watts)	One	100.00
	(iv)	10-litre, built in energy regulator, pilot lamp, two circuits (2 x 1000 watts)	One	120.00
16.	Pilot Essential oil distillation Unit:	Stainless steel 100 litre capacity still (effective vol 50 l) to work with steam, with a throttle valve for varying pressure, temp; S.S. condenser, florentine separator S.S. for lighter and heavier oils		2,000.00
			Total US$:	14,950.00

Annexure-IV

List of Chemicals

Name	Quantity	Price ($)
1. Acetic acid Glacial	2.5 l	21.00
2. Acetic anhydride (anhydrous)	10 x 500 ml	60.00
3. Acetone	2 x 2.5 l	28.00
4. Acetyl Chloride	5 x 100 ml	13.00
5. Benzene	8 x 2.5 l	79.00
6. Bromophenol blue	2 x 5 g	5.00
7. Calcium chloride (fused, anhydrous)	10 x 500 g	16.00
8. Cresol (ortho)	5 x 100 g	10.00
9. Chloroform	2.5 l	14.00
10. Cineole (1:8)	1 x 500 g	5.00
11. Diethylether	20 x 500 ml	67.00
12. Ethanol (95%)	4 x 2.5 l	15.00
13. Ethylene dichloride or 1:2 Dichloroethane	5 x 500 ml	15.00
14. Ethylene glycol	2 x 500 ml	8.00
15. Ferric Chloride	1 x 500 g	2.00
16. Normal - Hexane	2 x 2.5 l	20.00
17. Hydrochloric acid concentrated 35.4% 'AR'	2 x 2.5 l	17.00
18. Hydrochloric acid 0.5 N	2 x 2.5 l	10.00
19. Hydroxyl amine hydrochloride (Hydroxy ammonium chloride)	10 x 100 g	100.00
20. Lime (Quick)	2 Kg	1.00
21. Litmus paper Blue	2 Packets	2.00
22. Litmus Paper Red	2 Packets	2.00

Name	Quantity	Price ($)
23. Magnesium sulphate (anhydrous)	2 x 500 g	7.00
24. Methyl alcohol	2 x 2.5 l	17.00
25. Methyl orange	1 x 25 g	2.00
26. Methyl red	1 x 2.5 g	5.00
27. Nitric acid conc. 'AR'	500 ml	3.00
28. Oxalic acid 'Analar'	2 x 500 g	5.00
29. Petroleum ether (60-80°)	2 x 2.5 l	20.00
30. Phenolphthalein	1 x 50 g	2.00
31. Phenol red	1x 25 g	7.00
32. Phthalic anhydride	1 x 500 g	4.00
33. Potassium dichromate	1 x 500 g	6.00
34. Potassium hydroxide (Pellets)	20 x 1 Kg	143.00
35. pH Papers (2-10.5)	10 Packets	2.00
36. Silicon grease	4 x 50 g	13.00
37. Sodium acetate (fused)	4 x 500 g	16.00
38. Sodium bicarbonate	1 x 500 g	3.00
39. Sodium bisulphite	10 x 500 g	23.00
40. Sodium carbonate	5 x 1 Kg	21.00
41. Sodium chloride	1 x 1 Kg	3.00
42. Sodium Hydroxide Pellets	5 x 500 g	12.00
43. Sodium sulphate (anhydrous)	10 x 500 g	18.00
44. Sodium sulphite	5 x 500 g	10.00
45. Sulphuric acid 95-98% (sp. gr. 1. 84) 'AR'	2 x 2.5 l	22.00
46. Tartaric acid	2 x 500 g	19.00
47. Toluene	1 x 2.5 l	10.00
48. Xylene	1x 2.5 l	14.00
	Total US$	917.00

Annexure-V

List of Glassware

S.No.	Name	Specification	Quantity	Price($)
1.	Specific gravity bottles	10 ml	5	20.00
2.	Pyknometers	2 ml	5	8.00
3.	Beakers			
	(i)	25 ml	5	4.00
	(ii)	50 ml	5	4.00
	(iii)	100 ml	5	4.00
	(iv)	250 ml	10	10.00
	(v)	500 ml	10	17.00
	(vi)	1000 ml	5	19.00
4.	Volumetric flasks - class 'A'			
	(i)	10 ml	5	48.00
	(ii)	5 ml	5	50.00
	(iii)	50 ml	4	36.00
	(iv)	100 ml	2	19.00
	(v)	250 ml	2	23.00
	(vi)	500 ml	5	73.00
	(vii)	1000 ml	5	96.00
5.	Round Bottom flasks			
	(i)	50 ml socket 14/23	2	5.00
	(ii)	100 ml socket 24/29	5	17.00
	(iii)	250 ml socket 24/29	5	19.00
	(iv)	500 ml socket 24/29	5	22.00
	(v)	1000 ml socket 24/29	10	59.00
	(vi)	5000 ml socket 55/44	1	28.00
	(vii)	10000 ml socket 55/44	1	38.00
6.	Condensers			
	(i)	Liebig - Joint 24/29, length 400 mm	2	14.00
	(ii)	Double surface - Joint 24/29, length 300 mm	1	14.00
	(iii)	Allihn, Joint 24/29, length 400 mm	2	25.00
	(iv)	Liebig, Joint 14/23 length 300 mm	1	4.00
	(v)	Air condensers, cone 19/26, length 1100 mm	10	45.00
	(vi)	Liebig - Joint 19/26,length 300 mm	2	12.00
7.	(i)	Still head 24/29 (2-cones) 14/23 socket	3	19.00
	(ii)	Still head 14/23 (2-cones) 14/23 socket	2	8.00
	(iii)	Still head 19/26 (2 cones) 14/23 socket	2	9.00

S.No.	Name	Specification	Quantity	Price($)
8.	Vacuum receiver adapters			
(i)		24/29 socket, 24/29 cone	2	14.00
(ii)		14/23 socket, 14/23 cone	1	5.00
9.	Reduction adapters			
(i)		Cone 55/44 - socket 24/29	1	20.00
(ii)		Cone 24/29 - socket 14/23	2	6.00
(iii)		Cone 24/29 - socket 19/26	6	17.00
(iv)		Cone 19/26 - socket 14/23	2	4.00
10.	Expansion adaptors			
(i)		Cone 19/26 - socket 24/29	2	7.00
(ii)		Cone 14/23 - socket 24/29	2	7.00
11.	Stoppers			
(i)		24/29	10	20.00
(ii)		14/23	5	6.00
(iii)		19/26	5	7.00
12. (i)		Thermometer pockets 14/23 in two lengths	2	4.00
(ii)		Thermometer pocket 19/26 length 150 mm	1	3.00
13.	Measuring cylinders			
(i)		Stoppered class 'A' 10 ml, calib.0.1 ml	10	61.00
(ii)		Stoppered 25 ml calib. 0.5 ml	3	12.00
(iii)		Open – 50 ml calib. 1 ml	5	19.00
(iv)		Open - 100 ml calib 1 ml	5	23.00
(v)		Open - 500 ml - calib. 5 ml	5	53.00
(vi)		Open - 1000 ml - calib. 10 ml	2	29.00
(vii)		Open - 2000 ml - Calib. 20 ml	2	53.00
14.	Ordinary funnels (Sodaglass)			
(i)		Diam 5 cm	20	6.00
(ii)		Diam 10 cm	10	16.00
(iii)		Diam 15 cm	5	11.00
15.	Pipettes			
(i)		25 ml Transfer (1 mark)	5	10.00
(ii)		10 ml graduated (0.10 ml) class 'B'	5	10.00
(iii)		5 ml graduated (0.10 ml) class 'B'	5	9.00
(iv)		2 ml graduated 0.10, class 'A'	3	16.00
(v)		1 ml graduated 0.10 ml, class 'A'	3	14.00
(vi)		50 ml Transfer (1 mark)	2	15.00

S.No.	Name	Specification	Quantity	Price($)
16.	Test tubes with rim	15 x 125 mm	30	5.00
		15 x 150 mm	50	11.00
		18 x 150 mm	20	5.00
		25 x 200 mm	10	5.00
17.	Cassia flasks:	150 ml, neck 0-10 ml, Calib 0.1 ml, 150 mm length	20	193.00
18.	Clevenger - for determination of volatile oil from plant parts - 1000 ml flask, oil separatory tube and condenser			
	(i)	For lighter than water	5	175.00
	(ii)	For heavier than water	4	140.00
19.	Clevenger (Big) - for determination of volatile oil lighter than water comprising of oil separatory tube arm marked 0-50 ml, with cone 55/44, socket 45/40, Allihn condenser - cone 45/40, socket 24/29 Flask 10 l round bottom socket 55/44		2	400.00
20.	Separating funnels with stopcock & stoppers			
	(i)	2 litre spherical, socket 29/32, stopper 29/32	4	111.00
	(ii)	1 litre spherical, socket 29/32, Stopper 29/32	5	79.00
	(iii)	500 ml spherical, socket 24/29, Stopper 24/29	5	61.00
	(iv)	250 ml conical, socket 24/29, stopper 24/29	5	50.00
	(v)	100 ml conical, socket 14/23, stopper 14/23	5	45.00
	(vi)	50 ml conical, socket 14/23, stopper 14/23	5	35.00
21.	Conical flasks			
	(i)	Erlenmeyer narrow mouth 10 ml	5	4.00
		25 ml	5	5.00
		50 ml	5	6.00
		100 ml	5	7.00
		500 ml	20	40.00
		1000 ml	5	18.00
		250 ml	20	33.00
	(ii)	Erlenmeyer, narrow mouth with stoppers ic joint, 24/29, 100 ml	10	43.00
		19/20, 50 ml	5	19.00
		24/25, 250 ml	5	25.00
		29/25, 500 ml	4	25.00
		29/25, 1000 ml	3	35.00

S.No.	Name	Specification	Quantity	Price($)
22.	Burettes			
(i)		10 ml, graduation 0.05 ml	2	35.00
(ii)		25 ml, graduation 0.1 ml	5	89.00
(iii)		50 ml graduation 0.1 ml	5	100.00
23.	Round bottom flask 3 - neck - 5 litre Centre socket 29/32, parallel - 5°, 19/26, 10°, 24/29		1	115.00
24.	Ground seal gland for strirrers with cone 29/32 or Stuffing box gland cone PTFE cone 29/32 to fit shaft of 6 mm.		1	32.00
25.	Dessicators:			
(i)		Dia.25 cm ordinary	2	280.00
(ii)		Dia. 36 - 40 cm ordinary	2	420.00
(iii)		Vacuum dessicators 25 cm dia.	1	250.00
26.	Glass bottles for reagents:			
(i)		Stoppered 1000 ml narrow mouth	20	174.00
(ii)		Stoppered 250 ml narrow mouth	20	105.00
(iii)		Stoppered 2000 ml narrow mouth	2	31.00
(iv)		Stoppered 500 ml narrow mouth	50	300.00
(v)		Stoppered 125 ml narrow mouth	50	240.00
(vi)		Stoppered 60 ml narrow mouth	50	200.00
27.	Flat bottom flasks	100 ml	5	9.00
		250 ml	5	10.00
		500 ml	5	12.00
		1000 ml	4	13.00
		2000 ml	3	17.00
28.	Weighing bottles 50 x 25 mm		5	34.00
29.	Winchester bottles 5 l capacity and carriers for these		10	30.00
30.	Glass rods:			
(i)		4 mm x 1000 mm	10	20.00
(ii)		6 mm x 1000 mm	5	20.00
31.	Bends			
		24/29 (two cones)	1	5.00
		19/26 - 14/23 (two cones)	1	4.00
		14/23 (two cones)	1	3.00

S.No.	Name	Specification			Quantity	Price($)
32.	Soxhlet extraction apparatus complete with condenser					
		Capacity		Flask size		
	(i)	100 ml		250 ml	2	75.00
	(ii)	200 ml		500 ml	2	95.00
33.	Petridishes					
		Dia	Depth			
	(i)	50 mm	17 mm		10	18.00
	(ii)	100 mm	17 mm		10	22.00
	(iii)	150 mm	20 mm		5	22.00
34.	Glass Tubes					
		Outer diam	Innerdiam	Length		
		6 mm	4 mm	1 meter	5	15.00
		8 mm	6 mm	1 meter	5	20.00
		10 mm	8 mm	1 meter	4	20.00
35.	Bottles Mc Cartney withscrew cap & plastic liner					
		15 ml			One gross	75.00
		30 ml			One gross	105.00
36.	Filtering flasks					
	(i)	250 ml			2	6.00
	(ii)	1000 ml			1	5.00
					Total US$	5,857.00

Annexure- VI

List of Miscellaneous items

S.No.	Name	Specification	Quantity	Approx. Price($)
1.	Iron stands:	Ht. 120 cm	5	40.00
		Ht. 100 cm	5	30.00
		Ht. 60 cm	5	20.00
2.	Clamps - Asso rted (Retort,condenser etc.)		30	50.00
3.	Boss heads		30	35.00
4.	Ring clamps:	Diam. 4.5 cm	5	40.00
		Diam. 8 cm	5	
		Diam. 10.5 cm	5	
5.	Burette clamps		5	15.00
6.	Burette stands 'A' shapped		3	15.00
7.	Pipette stand to hold 10 - pipettes		2	8.00
8.	Test tube stands		2	8.00
9.	Test tube holders		2	8.00
10.	Cotton wool rolls		4	2.00
11.	Tissue Paper boxes		10	10.00
12.	Filter papers Whatman No.1			
	(i)	42.5 mm dia - boxes	10	30.00
	(ii)	55 mm dia - boxes	10	30.00
	(iii)	Sheets 570 x 460 mm - boxes	5	50.00
13.	Rubber tubing for condensers -	5 mm - meters	20	10.00
	for pressure	8 mm - meters	20	15.00
14.	Filter pumps to be used with water tap with nonreturn valve, nozzle for tubing		3	10.00
15.	Tubing connection of propylene - 7 mm straight		10	5.00
16.	Drainboards to dry glass wares		2	50.00
17.	China dishes 15 cm (dia)		2	4.00
18.	Porcelain tiles		4	2.00
19.	Enamel trays of different sizes		4	6.00
20.	Porcelain buchner funnels	80 mm	2	2.00
		125 mm	2	3.00

S.No.	Name	Specification	Quantity	Price($)
21.	Thermometers	360°	2	4.00
		250°	4	8.00
		110°	4	8.00
22.	Dial Type balance 0-20 kg		1	50.00
23.	Spatulas S.S. - assorted		6	6.00
24.	Beakers of polypropylene	500 ml	10	10.00
		1000 ml	10	16.00
		2000 ml	2	4.00
25.	Funnels of polypropylene	65 mm	5	3.00
		95 mm	5	4.00
		115 mm	5	5.00
		140 mm	5	7.00
26.	Wash bottles of polypropylene 250 ml		10	8.00
27.	Morter & Pestle of porcelain diam. 230 mm		1	2.00
28.	Cellophane adhesive tape (scotch)			
	12 mm - width - rolls		2	4.00
	25 mm - width - rolls		2	8.00
29.	Electical insulation adhesive tapes		2	5.00
30.	Glass marking pencils		10	6.00
31.	Marking pens		5	10.00
32.	Labels self adhesive 50 x 20 mm packets		2	10.00
		75 x 25 mm packets	2	15.00
33.	Bark corks - assorted size 8-13; Gross		2	25.00
34.	Rubber corks - assorted size, 8-13;gross		2	30.00
35.	Oridnary glass vials with polythene seal metal screw caps which can be sealed by machine			
	5 ml - gross		1	10.00
	25 ml - gross		1	30.00
36.	Boiling chips/shots (BDH) Bottle		1	10.00
37.	Cork borer set		1	5.00
38.	Filteration aid rubber cones - set of six of varying sizes		1	3.00

S.No.	Name	Specification	Quantity	Price($)
39.	Droppers	disposable (glass) with long jets		
		20 mm length - gross	1	20.00
		30 mm length - gross	1	30.00
40.	Rubber teats for above droppers		20	2.00
41.	(i) Brushes for cleaning burettes		20	20.00
	(ii) Brushes for cleaning test tubes		20	10.00
42.	Crucibles of porcelain	50 mm	2	4.00
		70 mm	2	5.00
		100 mm	2	10.00
43.	Tongs			
		200 mm (L) straight	2	6.00
		200 mm (L) withbow	2	6.00
		For holding flask	2	10.00
44.	Tripod stand triangular - 200 mm (ht)		5	7.00
45.	Triangles pipe clay		5	5.00
46.	Screw cap sealing machine		1	50.00
47.	Hot plate round - 250 mm (dia)		1	30.00
48.	Grass/leaf chopper to use material for pilot plant unit.		1	100.00
49.	Scissors:			
	(i)	Small - 15 cm length	1	2.00
	(ii)	Bigger - 25 cm length	1	5.00
50.	Hardwares: Set		1	100.00
	Consisting of screwdrivers, pliers, wrinches, triangular file for cutting copper tubes, glass rods/tubes and assorted hardwares.			
51.	Aluminium foil rolls		4	10.00
52.	Bunsen burners			
	(i)	small	1	5.00
	(ii)	medium	1	8.00
53.	Dial humidity indicators		2	10.00
54.	Dial thermometers		2	10.00
			Total:US$:	1,269.00