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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

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ASSISTANCE TO ESSENTIAL OIL INDUSTRY

DP/DRK/88/001/11-54

DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA

Technical report: Utilization of indigenous essential oils to develop suitable fragrance materials for local industry and export*

Prepared for the Government of
the Democratic People's Republic of Korea
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of M. L. Maheshwari, analytical chemist

Backstopping Officer: T. De Silva
Chemical Industries Branch

United Nations Industrial Development Organization
Vienna

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* This document has not been edited.

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TABLE OF CONTENTS

ABBREVIATIONS & ACRONYMS

AC = Analytical Chemist

C = Celsius

Cm = Centimeter

DB-1 = SE-30

DB-WAX = Carbowax 20M

DPRK = the Democratic Peoples Republic of Korea

Ed. = Edition

EOA = Essential Oils Association of U.S.A.

FID = Flame Ionization Detector

g = Gram

GC = Gas Chromatography

GOST = Russian Standard

ha = Hectare

ID = Internal diameter

IS = Indian Standard

ISO = International Standard Organization

kg = Kilogram

l = Length

m = meter

mm = millimeter

m/m = Man month

NMR = Nuclear Magnetic Resonance

NPD = National Project Director

NFT = French Standard

PCD = Petroleum and Chemical Division

PEORC = Pyongyang Essential Oils Research Centre

t = Metric ton

TC = Technical Committee

TCD = Thermal Conductivity Detector

tr = Traces

v/v = volume/volume

ABSTRACT

Dr. Mohan Lal Maheshwari, Analytical Chemist in the project ''Strengthening of the essential oils industry at Pyongyang, Democratic Peoples Republic of Korea, No. DP/DRK/88/001/11-54'' took up his assignment for one month (02 December, 1993 - 01 January, 1994). He was briefed by Special Technical Adviser and had discussions with National Project Director, Deputy Director, Chief Perfumer and Head Analytical Laboratory, PFORC about the project.

Principles and theory of Gas Chromatography and its application in essential oils, their isolates and aroma chemicals were explained to trainees. Demonstration was given on available Varian GC-3400. Various parameters were developed to analyse several essential oils, isolates and reference chemicals. Trainees were also shown how to check quality of essential oils, their isolates and monitoring processes like fractional distillation and reactions. GC column packing and maintenance of equipment was also explained with practical details. Standard specifications were developed for 8-products.

All the operation parameters, instructions, chromatograms and practical details are available at site. In addition to this expert has brought 137-standard specifications of different countries including International, 184-reference samples, library of 59-chromatograms, relevant literature and left at site.

Trainees have learnt techniques of using available uquipments and now they can handle by themselves and apply their use for quality control of essential oils and their isolates. Certain suggestions are made in the recommendations, which will further improve analysis efficiency.

Essential oils, their isolates and preparation of related aroma chemicals have great potential in DPR, Korea for use and export.

INTRODUCTION

The Project ''Strengthening of the Essential Oils Industry at Pyongyang Democratic Peoples Republic of Korea, No. DP/DRK/88/001/11-54'' was joined by Dr. Mohan L. Maheshwari, Analytical Chemist (A.C.) on 2 December, 1993. AC was briefed by Dr. Tuley De Silva, Special Technical Adviser, on 02 December, 93 in Colombo, Sri Lanka. AC arrived at site on 07 December, 93.

A.C. was shown around Pyongyang Essential Oils Research Centre facilities and Quality Control laboratory in particular. A.C. had detailed discussions with Dr. Choi Dung Gwang, NPD and director PEORC, Mr. Li Myong Ho, deputy director, Mr. Kim Byong Chol, Head, Analytical Laboratory and Mr. Yun Dae Won, Chief Perfumer about the activities and objective of PEORC.

Centre has following objectives:

1. Building up technical expertise in DPRK in all aspects of the essential oils industry
2. Rendering extensive service to other centres and to control quality of natural products
3. Establishing coordinated policy for cultivation of aromatic plants.

The project at Pyongyang needed streamlining procedures and techniques in analytical laboratory to evaluate the essential oils/isolates produced at present and for those, which are planned for near future.

DUTIES:

The expert was expected to work in collaboration with the NPD and Head, Analytical Lab. as shown in Job Description (Annexure-1). List of trainees who worked with expert is given in Annexure-2.

As requested by site, expert brought standard documents on desired essential oils and their isolates.

These included 45-International Standards (Annexure-3), 49-Essential Oil Association of U.S.A. Specifications (Annexure-4), 11-Indian Standards (Annexure-5), 1-French Standard & 1-Russian Standard (Annexure-6), 14-British Pharmacopea specifications (Annexure-7), 16-British Pharmaceutical Codex specifications (Annexure-8). He also brought 184-reference Standard Samples of essential oils, isolates and various aroma chemicals for identification and analysis of essential oils in the project (Annexure-9). Library of Gas Chromatograms of 59-samples, prepared by expert were brought to the site (Annexure-10). He also brought relevant standard Gas Chromatograms (6 & 21) of essential oils available in the literature (Annexure-11 & 12). Beside this A.C. also brought tables of variations, conversions and other relevant literature used in day to day work in quality control laboratory. All these materials are kept at site. All the assigned work was completed by expert. Salient features of the work done during the mission of expert are given in the following pages.

I. LECTURES & DISCUSSIONS ON THEORY AND APPLICATION OF GAS LIQUID CHROMATOGRAPHY

Four lectures were given to trainees as shown below:

Subject	No. of lectures
- Principle of GC & theory	1
- Description of equipment-Injector, oven, columns, detectors, integrator etc.	1
- Isothermal/temperature programming and analysis of essential oils/isolates	1
- Packed columns/capillary columns and analysis of essential oils/isolates	1

Trainees asked various clarifications about gas chromatography. This generated lot of discussions on various points.

II. COLUMN PACKING AND MAINTENANCE OF EQUIPMENT

Trainees were explained practical details about cleaning of columns, choosing support materials, stationary phase and proper solvents. Requirements of accessories in packing was explained. Methods were described for preparation of slurry, drying of packing material, packing in efficient way, preconditioning and conditioning of columns.

They were told in detail about maintenance and up keep of GC equipment, its accessories, spares, gas cylinders, regulators, voltage stabilisers etc. A write up on Do's and Don'ts was prepared for the site.

III. DEMONSTRATION OF AVAILABLE EQUIPMENT FOR QUALITY CONTROL OF ESSENTIAL OILS

Site has a Varian Gas Chromatograph Model 3400 (1984 make), with split/splitless injector, built in small printer plotter, a Thermal Coductivity Detector (TCD) and a Flame Ionization Detector (FID).

This was procured in 1991 Detector (FID) and Integrator are not efficient types. After installation of equipment proper demonstration was not made. Site also has DB-wax (polar) and DB-1 (non-polar) capillary columns. [30m(l), 0.32mm(I.D.), 0.25 micron coating].

After doing lot of work for a week machine was put on for demonstration with the help of Centre's Electronics engineer and all the colleagues of analytical section. GCs of certain essential oils/isolates were run. Some of these will be described in detail in Chapter V (Development of standard specifications).

IV. TRAINING IN QUANTITATIVE GLC ANALYSIS AND USE OF THE GLC IN QUALITY CONTROL

Trainees were given lectures on quaiitive and quantitative estimation of components in essential oils by using area calculation/area normalization method and their calculation. Demonstration on typical important essential oils were given and shown how their important constituents can be estimated, which reflect on their quality. They were also explained how quality of raw materials (essential oils) can be checked before processing them for isolation of useful/value added products. Examples are explained in details in Chapter V & VI.

V. DEVELOPMENT OF STANDARD SPECIFICATIONS FOR SELECTED 8--ESSENTIAL OILS

After discussion with NPD & Director PEORC, Deputy director, Head Analytical Division and Perfumer it was decided to develop specifications for following materials for demonstration purpose:

A. Rose concrete
B. Rose absolute
C. Mint oil
D. Angelica root oil
E. Oil of Perilla
F. Oil of Fagara
G. Oil of Abies
H. Oil of Thuja

A. ROSE CONCRETE

DPR, Korea is at present prcessing flowers of Rosa rugosa Thunb. to give 400 Kg rose concrete (0.20 to 0.24%) and having a capacity to go up to 1 t. This can be used for perfume formulations, creams and as a fixative. Its specifications are now described in Table-1. Colour of concrete is much lighter than R. damascena concrete.

B. ROSE ABSOLUTE

Rose absolute is prepared from rose concrete of Rosa rugosa Thunb. yield (45-50%) by extracting in ethanol, dewaxing and solvent removal. Specifications for rose absolute have been developed as shown in Table-2. It contains high percentage of total and free alcohols having very long lasting rosaceous odor. This kind of absolute is utilized as a base in modern perfumes, in combination with rose oil it gives excellent results. China also markets this kind of absolute, but no specification is available on this

GC composition of rose absolute is as follows:

Constituents	%	Constituents	%
Low boilers (Terpenes)	0.634	Citronellyl formate	0.043
Linalool	0.046	Geranyl formate	0.190
Phenylethyl alcohol	34.864	Eugenol	17.329
Rose oxides	tr	Geranyl acetate	0.646
Citronellol	6.754	Methyl eugenol	5.202
Citral-'b'	0,196	Unidentified	0.767
Nerol	0.978	Unidentified	0.358
Geraniol	7.852	Unidentified	1.180
Phenyl ethyl acetate	0.428	High boilers (stearoptenes)	17.31
Citral-'a'	0.109		

TABLE 1. SPECIFICATIONS OF ROSE CONCRETE (ROSA RUGOSA THUNB)

S. No.	Physico-chemical constants	Characteristics
1.	Appearance	Waxy semi-solid
2.	Colour	Yellow to light brown
3.	Odour	Rosaceous, heady, green slightly spicy, floral
4.	Fusion point	40-51°c
5.	Acid number	17-18
6.	Absolute content	45-50 %

TABLE 2. SPECIFICATIONS OF ROSE ABSOLUTE (ROSA RUGOSA THUNB)

S. NO.	Physico-chemical constants	Characteristics
1.	Appearance	Mobile liquid
2.	Colour	Dark brown
3.	Odour	Rosaceous, grassy, slightly spicy, long lasting floral
4.	Specific gravity (20° / 20°c)	0.9790 to 0.9880
5.	Refractive index (20°c)	1.5060 to 1.5130
6.	Optical rotation (20°c)	-2° to $+2^{\circ}$
7.	Acid value	15 to 23
8.	Ester value	23 to 36
9.	Ester value after acetylation	220 to 250
10.	Combined alcohols as geraniol (%)	6 to 10
11.	Free alcohols as geraniol (%)	65 to 72
12.	Total alcohols as geraniol (%)	71 to 82

C. MINT OIL

Oil of Mentha arvensis is already being produced (400t) and marketed. PEORC has identified a new hybrid and produced 400 kg oil. Its specifications were developed and given in Table-3. This oil gave Zerpenic, minty odour with a strong carvone note. Its menthol content was low while carbonyl content was high (65.3%). This was supported by its GC composition as given below:

Constituents	%	Constituents	%
Alpha-pinene	0.402	Menthone	7.960
Beta-pinene	1.160	Iso-menthone	1.379
Sabinene	1.047	Menthyl Acetate	0.572
Myrcene	0.434	Neo-menthol	1.462
Limonene	15.466	l-menthol	27.492
Gama-terpinene	0.324	Pulegone	tr
Para-cymene	0.173	Carvone+piperitone	41.389
Octanol-3	0.511	High boilers	0.249

TABLE 3: SPECIFICATIONS of MINT OIL (MENTHA ARVENSIS)

S.No.	Physico-chemical constants	Characteristics		
		D.P.R.Korea	ISO: 9776 Dementholised Oil	
			China	Brazil
1.	Appearance	Mobile liquid	Mobile liquid	Mobile liquid
2.	Colour	Colourless to light yellow	Colourless	Colourless
3.	Odour	Characteristic minty with carvone note	Characteristic	Characteristic
4.	Specific gravity (20° / 20°)	0.9193	0.880 to 0.908	o.689 to 0.900
5.	Refractive index (20°)	1.4778	1.4560 to 1.4660	1.4560 to 1.4666
6.	Optical rotation	- 26.39°	-17° to - 24°	-22° to -29°
7.	Miscibility in ethanol(70%v/v) at 20°C	2 volumes	3 volumes	4 volumes
8.	Acid value	1.3	1	1
9.	Ester value	35.43	5 to 18	8 to 30
10.	Ester content as Menthyl acetate	12.5 %	2 to 7 %	3 to 11 %
11.	Ester value after acetylation	74.3	150 to 208	144 to 180
12.	Total alcohol content as menthol	21.25 %	45 to 60 %	35 to 50 %
13.	Carbonyl value	237.8		91 to 164
14.	Carbonyl content as menthone (M. wt.154)	65.3 %		25 to 45 %

This oil will not serve purpose of mint oil, but can be used for flavour in tooth paste and confectionary after stripping of its terpenes and partial removal of menthol.

D. ANGELICA ROOT OIL

Angelica root oil is obtained by steam distillation of roots of Angelica gigas Nakai (0.2%). Production of this oil from wild material is about 1.5t at present. Specifications of this oil have been developed as shown in Table-4 and compared with those of EOA No. 96 for oil of A. archangelica produced in Europe. Physico-chemical constants and odour compare well. Its major components identified by GC are as follows:

Constituents	%	Constituents	%
Alpha-pinene + camphene+ Beta-pinene	78.930	Para-cymene + alpha terpinolene	0.741
Delta-3-carene + alpha phellandrene	0.698	Bornyl acetate	5.531
Limonene + beta - phellandrene	4.879		

Beside these major components, there are other trace coponents, which impart typical warm and biter woody note. It differs in concentration of components from oil of A. archangelica.

At present it is used for flavoring of alcoholic liqueurs. Its other properties like those of ginseng are under study. It is suggested that oil may be distilled for longer period (10 hrs) to get pentadecanoic lectone (musky odour) if present. Ethanolic extract may serve better for flavour and medicinal purpose.

TABLE 4: SPECIFICATIONS OF ANGELICA ROOT OIL (ANGELICA GIGAS NAKAI)

S.No.	Physico-chemical constants	Characteristics	
		DPR Korea	E.O.A. No. 96 A. archangelica oil
1.	Appearance	Mobile liquid	Liquid
2.	Colour	Colourless	Pale yellow to deep amber
3.	Odour	Warm pungent, long lasting and bitter woody taste	Warm pungent and bitter woody taste
4.	Specific gravity ($25^{\circ}C$)	0.8524 to 0.9070	0.850 to 0.880 occasionally to 0.930 (old roots)
5.	Optical rotation	$+0.83^{\circ}$ to $+14.43^{\circ}$	0° to $+46^{\circ}$
6.	Refractive index ($20^{\circ}c$)	1.4631 to 1.4813	1.4735 to 1.4870
7.	Acid value	3.37 to 7.2	Not more than 7
8.	Ester value	13	10 to 65
9.	Solubility in ethanol (90% v/v)	Soluble in 4 volumes	Soluble in 1 or more volumes, often with turbidity

E. OIL OF PERILLA

Oil of perilla is obtained by steam distillation of herb Perilla frutescens Britt. var. crispa Decne. forma viridis Makino (0.5 to 0.8 %) with a yield of 40 kg oil/ha, which is double of oil in Japan. About 1t oil is produced in DPR, Korea. Specifications for oil have been developed and shown in Table-5 and values compared with those given by Guenther. Its all properties including odour (cumin like) are comparable except optical rotation. Its GC composition is given in table below:

Constituents	%	Constituents	%
Alpha-pinene + camphene +		Unidentified	0.325
Beta pinene	0.228	Unidentified	0.639
Myrcene	0.306	Unidentified	34.034
Cis-beta ocimene +		Unidentified	2.932
gama-terpinene	4.452	Unidentified	2.605
Linalool	0.826	Unidentified	8.986
Camphor	0.130	Unidentified	2.837
Borneol	0.750	Unidentified	0.957
Methyl chavicol	0.071	Unidentified	0.606
Cuminaldehyde	0.121	Unidentified	2.258
Perilla aldehyde	4.284	Unidentified	20.351
Perilla alcohol	0.117		
Eugenol	0.131		

At present this oil is used as a flavouring agent in sauces, antiseptic, antimildew agent and oxime of perilla aldehyde as a sweetening agent for tobacco etc.

TABLE 5: SPECIFICATIONS OF OIL OF PERILLA

(PERILLA FRUTESCENS BRIT. VAR. CRISPA DECNE)

S.No.	Physico-chemical constants	Characteristics	
		DPR Korea	According to E. Guenther*
1.	Appearance	Mobile liquid	Liquid
2.	Colour	Colourless to light yellow	Light yellow to yellow
3.	Odour	Characteristic recalling perilla aldehyde	Characteristic recalling perilla aldehyde
4.	Specific gravity ($20^{\circ}/20^{\circ}$)	0.9230 to 0.9570	0.923 to 0.938 ($15^{\circ}/15^{\circ}$)
5.	Refractive index ($20^{\circ}c$)	1.4920 to 1.4998	1.4971 to 1.5048
6.	Optical rotation	-15°	-73.17° to -96.53°
7.	Acid value	0	1.0 to 1.5
8.	Saponification value	28.6	Abcut 40
9.	Ester value after acetylation	130. 8	----
10.	Aldehyde content as perilla aldehyde(%)	39 to 40%	39.0 to 54.8%
11.	Solubility in ethanol (90%, v/v)	Slightly opalescent even upto 10 volumes	Soluble in 0.5 or more volumes

* E. Guenther, The Essential Oils, Volume III. pp 687, Pub. Robert E. Kreiger, Huntington, N.Y. 1972.

F. OIL OF FAGARA

Oil of fagara is obtained by steam distillation of seeds with shell of Fagara schinifolia Sieb et Zucc (Rutaceae). Its oil content is 0.7 to 1 % and oil production is 1 to 2 t. Its specifications have been developed as described in Table-6. This oil is not produced elsewhere. Its odour is spicy, characteristic of estragole with anise note. At present it is used for flavour use locally. It is a very good source of natural methyl chavicol (89-90%), which can be used for natural flavour and can also serve as a raw material for production of anethole. GC composition of oil is as follows:

Constituents	%	Constituents	%
Benzalaldehyde	0.331	Cis-anethole	0.181
Beta-ocimenes	0.047	Trans-anethole	0.343
C-9 aldehyde	0.478	Eugenol	0.068
Linalool	0.060	Alpha-humulene	2.710
Methyl chavicol	89.53	High boilers	3.297
Anisaldehyde	0.459		

G. OIL FROM ABIES

Abies oil is produced by steam distillation of needles of Abies nephrolepis Maxim, giving 2 % oil yield. Production of this oil is about 100t. There is no such oil produced elsewhere, other two oils are from A. sibrica Ledeb in Siberia and A. alba Mill in Europe.

TABLE 6: SPECIFICATIONS OF OIL OF FAGARA SEEDS

(FAGARA SCHINIFOLIA SIEB ET ZUCC)

S.No.	Physico-chemical constants	Characteristics
1.	Appearance	Mobile liquid
2.	Colour	Light yellow
3.	Odour	Spicy, characteristic of estragole with anise note
4.	Specific gravity (20° C)	0.9916
5.	Refractive index (20° C)	1.5262
6.	Optical rotation	$+0.05^{\circ}$
7.	Acid number	2
8.	Ester number	46.73
9.	Aldehyde content as anisaldehyde (mol.wt.136)	1.5 to 2.8%
10.	Solubility in ethanol (90 %, v/v)	Soluble in 0.5 volume

Specifications of this oil have been developed and compared with other two oils as shown in Table-7. Oil has a very refreshing odour of fir needles.

Major components identified by GC are as follows:

Constituents	%	Constituents	%
Thujene + alpha-pinene	27.134	Limonene + beta-phellandreme	18.185
Camphene	27.393	Para-cymene + terpinolene	0.334
Beta-pinene	4.521	Longifolene	1.356
Delta-3-carene +		Bornyl ace ate	15.253
alpha-phellandrene	2.620		

Oil composition is more to wards oil from China, but having higher bornyl acetate. Due to its unique odour it finds ise in soaps, air refreshners, disinfectants. Its oil is also used as an antipyretic drug.

H. OIL OF THUJA

Oil of thuja is produced from leaves (2.4%) and leaves + small twigs (1.5%) of Thuja koraiensis Nak (Cubressaceae). Oil production is around 100t. Specifications for oil have been developed as shown in Table-8 and compared with those of oil from T. occidentalis L. (cedar leaf oil). Oil has refreshing odour of pine needle with note of thuja. This is further confirmed by GC composition of oil as given below:

Constituents	%	Constituents	%
Thujopsene	0.506	Alpha-thujone + Beta-thujone(less)	21.54
Alpha-pinene	4.269	Camphor	tr
Beta-pinene	9.088	Longifolene	tr
Delta-3-carene + Alpha-phellandrene	2.377	Unidentified	0.310
Limonene + beta-phellandrene	4.423	Unidentified (caryophyllene?)	11.972
Unidentified (Fenchone?/C8-aldehyde?)	22.776	Bornyl acetate	19.129

As this oil has low content of monoterpenic hydrocarbons and more oxygenated terpenes, it will be stable for a longer period. It can therefore be used in perfume formulation, deodorants, soap, cream etc. This oil is slightly different from oil of T. occidentalis.

TABLE 7: SPECIFICATIONS OF OIL FROM ABIES NEPHROLEPIS MAXIM

S.No.	Physico-chemical Constants	CHARACTERISTICS DPR korea	EOA: 50 A. sibrica Ledeb	EOA: 126 A. alba Mill
1.	Appearence	Mobile liquid	Liquid	Liquid
2.	Colour	Colourless to faint yellow	Colourless to faint yellow	Colourless to pale yellow
3.	Odour	Pleasant and refreshing odour of fir needles	Fragrant pine note	Freshly cut fir needle odour
4.	Specific gravity (25°C)	0.8905 to 0.9440 (20°C)	0.898 to 0.912	0.867 to 0.878
5.	Refractive index (20°C)	1.4574 to 1.4701	1.4685 to 1.4730	1.4700 to 1.4750
6.	Optical rotation	-8.56°	-33° to -45°	-30° to -67°
7.	Acid value	0.87	___	___
8.	Ester value	92.62	___	___
9.	Bornyl acetate (%)	32.36%	32 to 44%	4 to 10%
10.	Solubility in 90% ethanol (v/v)	Soluble in 3 volumes	Soluble in 1 volume, hazy on further dilution	Soluble in 7 volumes

TABLE 8: SPECIFICATIONS for OIL of THUJA (THUJA KORAIENSIS NAK)

S.No.	Physico-chemical Constants	CHARACTERISTICS DPR Korea	E.O.A. 86 Oil cedar leaf T. Occidentalis L.
1.	Appearance	Mobile liquid	Mobile liquid
2.	Colour	Colourless	Colourless to yellow
3.	Odour	Strong camphoraceous	Strong camphoraceous
4.	Specific gravity	0.9045 (20° C)	0.910 to 0.920 (25° C)
5.	Refractive index (20° C)	1.4690	1.4560 to 1.4590
6.	Optical rotation	-2.11°	-10° to -14°
7.	Acid value	0.96	___
8.	Ester value	31.2	___
9.	Carbonyl content % (Calculated as thujone)	46%	Min. 60%
10.	Solubility in 70% ethanol (v/v)	Soluble in 2 volumes	Soluble in 3 volumes, cloudy on further dilution

VI. PROTOCOLS FOR PROCESS MONITORING

Trainees were explained how to develop protocols for various process monitoring with the help of Gas Chromatography. Protocols were demonstrated for monitoring following processes:

A. Extraction of rose absolute from concrete.

B. Rectification/fractional distillation of Mentha, Fagara, Abies, Thuja and Perilla.

C. Isolation of menthol and preparation of dementholised oil.

D. Isolation of methylchavicol from Fagara oil.

Trainees have also been given GC protocols for isolation/enrichments of various isolates and aroma chemicals from many other essential oils. Therefore in future they can monitor production of aroma chemicals when industry grows further.

VII. ACCESSORY EQUIPMENT FOR IMPROVEMENT OF ANALYSIS

Following accessories and equipments may be provided in the project to improve efficiency of analytical lab. further:

		Quantity
1.	Automatic Servo Controlled Voltage stabilizer with capacity of correction of 30 volts/second-220 volts, 60 Herz, 2 kilowats	one
2.	Twc Stage Pressure regulator for hydrogen cylinder - varian catal. No. 57-000180-00	one
3.	Two Stage Pressure regulator for nitrogen cylinder - varian catal. No. 57-000180-00	one
4.	Carrier gas filter - varian catal. No. 68-000070-00	one
5.	Hypodermic syringes 1 micro litre	six

6. Capillary GC narrow bore columns (0.25mm I.D.)

	phase	length(m)	film thickness (micron)	Varian cat. No.	
(i)	DB-1	60	0.25	JW-122106-20	one
(ii)	DB-5	30	0.25	JW-122503-20	one
(iii)	DB-wax	60	0.25	JW-122706-20	one

7. Packed GC columns with chromosorb WHP(80-100)

	phase	length (m)	I.D. (2mm)	Material	Varian cat. No.	
(i)	10 % Carbowax-20m	2	2	glass	03-912050910	one
(ii)	10 % Didecyl phthallate	4	2	stainless steel	03-912533-32	one
(iii)	3 % ov-17	2	2	stainless steel	03-912503-32	one

8.	P.H.meter	one
9.	Colorimeter	one

VIII. ADVICE ON PREPARATION OF AROMA CHEMICALS USING LOCAL ESSENTIAL OILS

Based on the discussions held at site following suggestions are made:

A. At present DPR, Korea is marketing mint oil, for which good price is not offered. It is suggested that l-menthol be separated partially and two products - l-menthol and dementholized oil can be marketed. Usually dementholized oil with about 40% l-menthol is marketed world wide. Another mint oil examined during this programme is not suitable for isolation of menthol, but after deterpination and partail removal of menthol, it can serve as a good material for flavour of spearmint.

B. Fagara oil, rich in methyl chavicol(90%) not reported in literature so far, can serve as a very good source of natural methyl chavicol. Its odour/flavour is very excellent. As Fagara plant grows wild, its oil can be used for manufacture of anethole also.

C. Rose concrete and absolute of Rosa rugosa are not well known in International markets, attempts may be made to popularise these, as prices of concrete and absolute of R. damascena (Bulgaria & Turkey) are very high.

D. Abies and Thuja oils as such or after rectification can go for perfumery formulation in air refreshners, soaps as having fresh pine leaf odour. Other Abies oils available are from Siberia, China and Europe and they are from different species. These are better than European oils.

E. Angelica root oil produced in DPR, Korea is from Angelica gigas, which is different from A. archangelica of Europe. Warm and bitteer woody note of this oil is highly preferred in liqueur manufacture. It is suggested that oil may be distilled for longer duration of 10 hr in order to get high boiling compounds to impart medicinal flavour and musky odour.
Locally it is known to have ginseng properties.

F. Attempts may be made to select varieties of perilla rich in perilla aldehyde.

G. It is suggested that cultivation of plants like - lavender, Mentha citrata, M. piperita, M. spicata, Clary sage and geranium may be intensified for production of their oils.

RECOMMENDATIONS

In order to make best use of the project following recommendations are made from analysis and quality control point of view:

1. For improvement and regular maintenance in analytical laboratory following may be provided:
   (i) Services of maintenance engineer from Varian for rectifying several faults in Gas Chromatograph. Detector and integrator are erratic and base line drift is very much.
   (ii) Automatic servo controlled voltage stabilizer (2kw) to suppress noise and spikes due to high voltage fluctuation in GC (Chapter VII).
   (iii) GC-spares like - columns, syringes, gas filter and pressure regulators for hydrogen and nitrogen cylinders (details in Chapter VII).
   (iv) PH-meter and a colorimeter to measure pH and color pigments during analysis of plant extracts (Chapter VII).
2. Books and journals as drawn in the list (Annexure-13) may be provided.
3. Quality of essential oils:
   (i) Most interesting essential oil found during this mission was Fagara oil, which contains almost 90% of methyl chavicol - a highly useful odour/flavour chemical, as well as used for synthesis of anethole of anise aroma.
   (ii) Absolute of Rosa rugosa has long lasting rosaceous, spicy aroma. This may be made to popularise in International Markets, as its price is lesser than that of R. damascena of Bulgaria and Turkey.
   (iii) Abies oil is more towards oils from China and Siberia having refreshing note of freshly cut pine needle, hence should find use in deodorants, soaps, creams etc.

(iv) Thuja oil is also having refreshing long lasting pine note, hence may find similar use as Abies oil. Shelf life of oil will be better due to lower amounts of monoterpenic hydrocarbons and higher amounts of oxygenated compounds.

(v) Mentha oil of a hybrid variety examined, should give a good flavour material on rectification for toothpaste and confectionary.

(vi) Angelica roots may be distilled for longer duration to get more medicinal bitter flavour. Alternatively this may be extracted by solvents to get more medicinal extractive for liqueour flavour.

(vii) Perilla plant varieties may be screened for higher perilla aldehyde contents.

4. Cultivativation of other aromatic plants suitable in climatic and soil conditions of DPR, Korea - like lavender, Mentha citrata, M. piperita, M. spicata, clary sage, geranium etc. can be attempted.

5. Possibility of production of cedar wood oil and screening of essential oils of wild growing plants may be explored.

ANNEXURE 1

JOB DESCRIPTION

DP/DRK/88/001/11-54

Post Title: Analytical Chemist (Essential Oils)

Duration: 1 m/m

Date Required: June 1993

Duty Station: Pyongyang

Purpose of Project: Utilization of indigenous essential oils to develop suitable fragrance materials for local industry and export.

Duties: The expert will work in collaboration with the National Project Director and counterpart staff in carrying out the following:

1. Conduct lectures/discussions on theory and application of Gas Liquid Chromatography.
2. Demonstrate the use of available equipment for quality control of essntial oils.
3. Train the couunterpart staff in quantitative GLC analysis and use of the GLC in quality control.
4. Assist in development of standard specifications for selected essential oils.
5. Develop protocols for process monitoring.
6. Train counterpart staff in column packing and maintenance of equipment.
7. Recommend accessory equipment needed for improvement of analysis.
8. Advice on preparation of aroma chemicals using local essential oils.

The expert is expected to bring with him available international standards (ISO) on desired essential oils, standards of essntial oil association of USA(EOA) on isolates, reference samples of aroma chemicals and essential oils and gas chromatograms of reference oils and isolates.

The expert will also furnish a completed and fully processed terminal report on the work done by him at the completion of his mission outlining the findings and his recommendations for follow-up action.

ANNEXURE - 2

LIST OF TRAINEES

1.	Mr. Kim Byong Chol	Head Analytical Lab.
2.	Ms. Hong Dong Suk	Analytical Engineer
3.	Ms. Kang Gum Suk	Chemist
4.	Mr. Kim Gwang Nam	Electronics Engineer

ANNEXURE 3

International Standard (ISO) TC 54

S.No.	Reference	Ed.	Pages	Title
1.	ISO 590-1981	1	2	Oil of Brazilian Sassafras
2.	ISO 770-1980	1	2	Oil of Eucalyptus globulus
3.	ISO 855-1981	1	2	Oil of lemon, Italy, obtained by expression
4.	ISO 856-1981	1	3	Oil of Peppermint, France, Italy, United Kingdom and USA
5.	ISO 1202-1981	1	3	Essential oils - Determination of 1,8 - Cineole content
6.	ISO 3033-1988	2	4	Oil of spearmint (Mentha spicata Linnaeus)
7.	ISO 3044-1974	1	2	Oil of Eucalyptus citriodora
8.	ISO 3064-1977	1	2	Oil of Petitgrain, Paraguay
9.	ISO 3140-1990	1	2	Oil of Sweet orange (Citrus sinensis (Linnaeus) obsbeck) obtained by mechanical treatment
10.	ISO 3214-1974	1	2	Oil of Litsea cubeba
11.	ISO 3216-1974	1	2	Oil of Cassia
12.	ISO 3217-1974	1	2	Oil of lemon-grass (Cymbopogon citratus)
13.	ISO 3475-1975	1	2	Oil of aniseed
14.	ISO 3515-1987	2	4	Oil of French lavender (Lavandula angustifolia p.Miller)
15.	ISO 3516-1980	1	2	Oil of coriander
16.	ISO 3519-1976	1	2	Oil of lime, obtained by distillation
17.	ISO 3520-1980	1	2	Oil of bergamot, Italy
18.	ISO 3523-1976	1	2	Oil of Cananga

S.No.	Reference	Ed.	Pages	Title
19.	ISO 3524-1977	1	2	Oil of Cinnamon leaf
20.	ISO 3526-1991	2	4	Oil of sage (Salvia lavandulifolia)
21.	ISO/DIS 3528-1989	2	5	Oil of mandarin, Italy
22.	ISO 3809-1987	2	5	Oil of Lime, Mexico (Citrus aurantiifolia (Christmann) Swingle) obtained by mechanical means.
23.	ISO 3848-1976	1	2	Oil of Java citronella
24.	ISO 4716-1987	1	5	Oil of Vetiver (Vetiveria zizanioides (Linnaeus) Nash)
25.	ISO 4718-1981	1	2	Oil of Lemon grass (Cymbopogon flexuosus)
26.	ISO 4724-1984	1	2	Oil of cedarwood, Virginia (Juniperus virginiana Linnaeus)
27.	ISO 4725-1986	1	2	Oil of cedarwood, Texas (Juniperus mexicana scheide)
28.	ISO 4727-1988	1	4	Oil of palmarosa (Cymbopogon martinii (Roxburgh) W.Watson var. motia)
29.	ISO/DIS 4730-1933	1	4	Oil of Melaleuca-Terpinen-4 ol type
30.	ISO 4731-1978	1	3	Oil of geranium
31.	ISO 4732-1983	1	2	Rectified oil of Eucalyptus globulus labillar diere, Portugal
32.	ISO 7356-1985	1	4	Oil of thujone-containing artemisia and oil of sage (Salvia officinalis Linnaeus) Determination of a- and b-thujone content-Gas Chromatographic method on packed columns.
33.	ISO 7359-1985	1	7	Essential oils - Analysis by gas chromatography on packed columns-General method.

S.No.	Reference	Ed.	Pages	Title
34.	ISO 7609-1985	1	7	Essential Oils-Analysis by Gas chromatography on capillary columns-General method.
35.	ISO/DIS 8433-1993	1	5	Oils of rose-Determination of citronellol, nerol, geraniol contents - Gas chromatographic method on capillary columns
36.	ISO 8897-1991	1	5	Oil of juniper berry (Juniperus communis Linnaeus)
37.	ISO/DIS 8898-1991	1	4	Oil of mandarin petitgrain (Citrus reticulata Blanco)
38.	ISO 8899-1991	1	5	Oil of lemon petitragrain (Citrus limon (Linnaeus)N.Burman)
39.	ISO 8900-1987	1	3	Oil of bergamot petitragain (Citrus aurantium (Linnaeas) ssp. bergamia (Wight et.Arnott) Engler)
40.	ISO 8901-1987	1	4	Oil of bitter orange petitragrain (Citrus aurantium Linnaeus ssp. aurantium)
41.	ISO/DIS 9776-1990	1	7	Oil of Mentha arvensis, partially dementholized (Mentha arvensis Linnaeus var. piperascence Malivaud var. glabrat Holmes
42.	ISO 9842-1991	1	3	Oil of rose (Rosa damascena P. miller)
43.	ISO 9843-1991	1	4	Oil of cedarwood (Cupressus funebris Endlicher)
44.	ISO 9844-1991	1	4	Oil of bitter orange (Citrus aurantium Linnaeus ssp. aurantium)
45.	ISO/DIS 11020-1993	1	6	Oil of turpentine (Pinus pinaster Ait)

Draft in circulation

ANNEXURE 4

Specifications of Essential Oil Association of USA (E.O.A.)

S.No.	(Sec.II) Essential Oils	Specification Number
1. .	Oil of Petitgrain Paraguay	3
2.	Oil lemon grass	7
3.	Citronella oil	14
4.	Cajeput oil	22
5.	Vetiver oil	24
6.	Oil palmarosa	29
7.	Oils cedarwood-Texas & Virginia	36
8.	Oil geranium Reunion	49
9.	Oil of Siberian Fir Needles	50
10.	Oil geranium Algerian	53
11.	Cinnamon leaf oil	56
12.	Camphor oil	69
13.	Oil limes distilled	78
14.	Oil Cedar leaf	86
15.	Oil cinnamon bark Ceylon	87
16.	Oil limes expressed	88
17.	Oil tangerine expressed	94
18.	Oil mandarin expressed	95
19.	Oil angelica root	96
20.	Oil angelica seed	97
21.	Fir needle oil canadian	112
22.	Oil of basil (Reunion)	120
23.	Oil Abies alba	126
24.	Oil Eucalyptus citriodora	130
25.	Turpentine Russian oil (Pinus sylvestris)	133

26.	Oil bitter orange	155
27.	Oil dill seed European	158
28.	Oil dill seed Indian	159
29.	Oil geranium Moroccan	160
30.	Oil Cedar wood Atlas	229
31.	Turpentine oil recitified	252
32.	Bergamot oil expressed	256
33.	Lemon oil Arizona	272
34.	Oil lemon distilled	291
35.	Oil orange distilled	292

Sec. VI	Aromatic chemicals & Isolates	Specification Number
36.	Hydroxy citronellal	5
37.	Terpeneol	8
38.	Geranyl acetate	11
39.	Citral pure	15
40.	Geraniol	16
41.	Citronellol	17
42.	Ionones	61
43.	Citronellyl acetate	125
44.	Geranyl formate	162
45.	Cinnamic aldehyde	204
46.	Linalool synthetic	226
47.	Citronellal	227
48.	d-Limonene	253
49.	Eucalyptol	288

ANNEXURE 5

INDIAN STANDARDS

(Natural and Synthetic Perfumery Materials Sectional Committee

PCD 18, Bureau of Indian Standards)

S.No.	IS No.	Title
1.	326 : 1968	Method of sampling and test for natural and synthetic perfumery materials.
2.	526 : 1988	Oil of Palmarosa
3.	533 : (Revision)	Gum Spirit of turpentine (Oil of turpentine)
4.	3124 : 1992	Terpeneol
5.	3925 : 1980	Eugenol
6.	5757 : (Revision)	Pine oil
7.	13358 : 1992	Part 1 : code of Practice for cultivation of aromatic plants : Geranium
8.	13358 : 1992	Part 2 : Code of Practice for cultivation of aromatic plants : Lemongrass
9.	13358 : 1992	Part 3 : Code of Practice for cultivation of aromatic plants : Citronella (Java)
10.	13358 : 1992	Part 4 : Code of practice for cultivation of aromatic plants : Mentha arvensis (Japanese mint) and Mentha citrata (Bergamint).
11.	13358 : 1993	Part 5 : Code of practice for cultivation of aromatic plants: Mentha piperita (Pepermint) and Mentha spicata(Spearmint)

ANNEXURE 6

FRENCH STANDARD

ESSENTIAL OIL	SPECIFICATION NUMBER
Basil, Oil-methyl Chavicol type (Ocimum basilicum Linnaeus)	NFT 75-357

RUSIAN STANDARD

Essential oil	Specification Number
Ocimum gratissimum, oil	GOST 9361-60

ANNEXURE 7

BRITISH PHARMACOPOEA 1980 VOLUME I

S.No.	Name of item	Paage No.
1.	Anise oil (Aniseed oil)	36-37
2.	Aniseed	37
3.	Cinnamon (Bark : Ceylon Cinnamon)	113-114
4.	Cinnamon oil	114
5.	Eucalyptus oil	189
6.	Eugenol	189-190
7.	Lemon oil	252
8.	Terpeneless lemon oil	253
9.	Dried lemon peel	253
10.	Orange oil	317
11.	Terpeneless orange oil	317
12.	Dried bitter orange peel	317
13.	Terpineol	444
14.	Turpentine oil	469

ANNEXURE 8

BRITISH PHARMACEUTICAL CODEX 1973

S.No.	Name of item	Page No.
1.	Anise oil	30
2.	Cajuput oil	64
3.	Cineole	112-113
4.	Cinnamon	113-114
5.	Cinnamon oil	114
6.	Citronella oil	115
7.	Eucalyptus oil	193
8.	Eugenol	193
9.	Lemon oil	264
10.	Terpeneless lemon oil	264
11.	Dried lemon peel	265
12.	Orange oil	339
13.	Terpeneless orange oil	339
14.	Dried bitter orange peel	339-340
15.	Terpeneol	494
16.	Turpentine oil	524-525

ANNEXURE 9

List of Reference chemicals/isolates/essential oils

1. Alcohol C-8 (n-octanol)
2. Alcohol C-10 (n-decanol)
3. Alcohol C-12
4. Aldehyde C-8
5. Aldehyde C-9
6. Aldehyde C-10
7. Aldehyde C-12
8. Anethole
9. Anise oil (NBPGR)
10. Anisic aldehyde
11. Artemisia ketone
12. Asarone
13. Benzaldehyde
14. Benzyl acetate
15. Benzyl alcohol
16. Benzyl benzoate
17. Bergamot oil
18. Borneol
19. Cajeput oil (Vietnam)
20. Camphor
21. Cardamom oil
22. Carene-delta-3
23. Carvone-1
24. Caryophyllene
25. Cedarwood oil (Indian)
26. cedryl acetate
27. Cineole-1:8
28. Cinnamic alcohol
29. Cinnamic aldehyde
30. Cinnamon oil-Cassia (Vietnam)
31. Cinnamon oil leaf(Pemba)
32. Cinnamyl acetate
33. Citral
34. Citronella oil
35. Citronellal
36. Citronellol
37. Citronellyl acetate
38. Citronellyl butyrate
39. Citronellyl formate
40. Clocimum oil
41. Clove bud oil(Pemba)
42. Clove leaf oil (Indonesia)
43. Clove stem oil (Pemba)
44. Coriander oil
45. Cuminyl alcohol
46. Damascone
47. Dementholised mint oil
48. Dill seed oil
49. Dimethyl hydroquinone
50. Dimethyl octanol
51. Dipentene
52. Eucalyptus citriodora oil
53. Eucalyptus globulus oil
54. Eugenol
55. Eugenyl acetate
56. Farnesol
57. Geijerene & pre-geijerene

58. Geraniol (ex. citronella oil)
59. Geraniol (ex. palmarosa oil)
60. Geraniol (commercial)
61. Geranium oil -Bourbon
62. Geranium oil Indian comm.
63. Geranium oil-Hyderabad
64. Geranyl acetate-commercial
65. Geranyl acetate-NBPGR
66. Geranyl butyrate
67. Geranyl caproate
68. Geranyl formate
69. Geranyl iso-valerate
70. Hexenol-cis-3
71. Hexenyl acetate-cis-3
72. Hydroxy citronellal
73. Ionone-Alpha
74. Ionone-Beta
75. Indole
76. Isoborneol
77. Isobornyl acetate
78. Isoeugenol
79. Isoeugenyl acetate
80. Isopulegol
81. Isosafrole
82. Jamrosa oil
83. Lavandin absolute
84. Lavender oil
85. Lemon grass oil-C. citratus (Pemba)
86. Lemon grass oil-C. flexuosus-India
87. Lemon grass oil-Hybrid-CKP-25-India
88. Lemon grass oil (Vietnam)
89. Lemon oil -expressed
90. Lime oil - expressed
91. Lime oil - distilled
92. Limonene
93. Linalool - d
94. Linalool - l
95. Linalyl acetate
96. Litsea cubeba oil (Vietnam)
97. Longifolene
98. Mandarin oil
99. Melaleuca oil
100. Mentha arvensis oil-Shivalic
101. Mentha citrata oil
102. Mentha piperita oil
103. Mentha spicata oil
104. Menthol
105. Menthone/Iso-menthone
106. Menthofuran
107. Menthyl acetate
108. Menthyl anthranilate
109. Methyl chavicol (Estragole)
110. Methyl cinnamate
111. Methyl eugenol
112. Methyl heptenone
113. Methyl ionone

114. Methyl salicylate

115. Nepeta lactone cis, cis-

116. Nepeta lactone cis, trans-

117. Nerol

118. Nerolidol

119. Neryl acetate

120. Nonanol (Alcohol C-9)

121. Beta-Ocimene-cis & trans

122. Ocimum basilicum(EC-282721-eugenol-methyl chavicol)

123. Ocimum basilicum (EC-174527-Linalool type)

124. Ocimum basilicum(Badaun-Methyl chavicol type)

125. Ocimum basilicum(EC-291415 A Comores-Methyl chavicol)

126. Ocimum basilicum(EC_291415 B Comores-Methyl chavicol)

127. Ocimum basilicum(EC-291415 C Comores-Methyl chavicol)

128. Ocimum basilicum(Vietnam-Methyl chavicol type)

129. Ocimum basilicum(EC-112545-Methyl cinnamate type)

130. Ocimum canum (Linalool-d)

131. Ocimum gratissimum(Vietnam)

132. Ocimum sanctum oil

133. Olibanum oil

134. Orange oil-expressed

135. Orange oil-20fold

136. Orange bitter leaf oil-20fold

137. Palmarosa oil (IC-31245)

138. Patchouli oil (Imported-Indoneisian)

139. Patchouli oil (Imported-K.L.KOH)

140. Patchouli oil (standard-K.L.KOH)

141. Patchouli oil (NBPGR-Indonesian)

142. Patchouli oil (NBPGR-Johore)

144. Perilla aldehyde

145. Petigrain bitter orange oil

146. Petigrain oil-Paraguay

147. Phellandrene-Beta

148. Phenyl ethyl acetate

149. Phenyl ethyl alcohol

150. Pine oil (CAP)

151. Pinene-Beta

152. Piperonal (Heliotropine)

153. Pulegone

154. Rose absolute

155. Rose concrete

156. Rose oil

157. Rose oxide cis & trans

158. Safrole

159. Sandalwood oil
160. Sasafrass oil
161. Star anise oil (Vietnam)
162. Tagette oil
163. Tengerine oil - expressed
164. Terpenene-Alpha
165. Terpin-one-4-ol
166. Terpineol-alpha
167. Terpinyl acetate
168. Thujone-alpha
169. Thujone-beta
170. Thymol
171. Turpentine oil(CAP-India)
172. Turpentine oil (Vietnam)
173. Vanillin
174. Vetiver oil (Imported-Haiti)
175. Vetiver oil (Imported-Indonesia)
176. Vetiver oil (Imported-Reunion)
177. Vetiver oil (cultivated-Karnataka)
178. Vetiver oil (Hydrid-8,NBPGR)
179. Vetiver oil (NC-66416,NBPGR)
180. Vetiver oil (SHK-NBPGR)
181. Vetiver oil (South Indian type-NBPGR)
182. Vetiver oil (NC-66404,NBPGR)
183. Vetiverol
184. Vetiveryl acetate

Annexure 10

Reference Gas Chromatograms

1. Agar wood oil
2. Anise oil
3. Artemisia oil (2)
4. Basil oil-eugenol type
   EC-282721
5. Basil oil - linalool type
   EC-174527
6. Basil oil-methyl chavicol type (3)
   EC-291415
7. Basil oil-methyl cinnamate type
   EC-112545
8. Cajeput oil (2)
9. Cassia oil (2)
10. Cinnamomum zeylenicum leaf oil
11. Citral
12. Citronellal
13. Citronella oil (4)
14. Citronellol
15. Citronellyl acetate
16. Citronellyl butyrate
17. Citronellyl formate
18. Clove bud oil
19. Clove stem oil
20. Coriander oil
21. Dill seed oil
    (Anethum sowa Roxb)
22. Eucalyptus citriodora
    oil
23. Fokeina hodginsii
    oil
24. Geraniol
25. Geranium oil (2)
26. Geranyl acetate
27. Geranyl butyrate
28. Geranyl formate
29. Isobornyl acetate
30. Jamsosa oil
31. Lemongrass oil (4)
32. Lemongrass oil hybsid
    CKP-25
33. Lime oil
34. Litsea cubeba oil

35. Mausambi oil (Citrus sps.)
36. Mentha arvensis oil (2)
37. Mentha spicata oil
38. Nerol
39. Ocimum canum oil
40. Ocimum gratissimum oil (2)
41. Ocimum sanctum oil
42. Ocimum sauve oil
43. Palmarosa oil
44. Perilla seed oil
45. Petitgrain oil (4)
46. Pine oil (India)
47. Pine oil (Vietnam)
48. Pine oil special (CAP,India)
49. Pogostemon cablin oil
    (Patchouli oil)
50. Pogostemon plectanthoides oil
51. Rose oil
52. Sandal wood oil
53. Sassafras oil
54. Star anise oil
55. Terpenyl acetate
56. Turpentine oil (2)
57. Vetiver oils (11)
58. Vetiverol
59. Vetiveryl acetate

ANNEXURE 11

Analysis of essential oils by Gas Chromatography and Mass Spectrometry by Yoshiro Masada-John Wiley and Sons Inc.

1. Angelica oil
2. Anise oil
3. Cedar oil
4. Lemon grass oil
5. Perilla oil
6. Rose oil

ANNEXURE 12

Essential oil analysis by Capillary Gas Chromatography and C13 NMR Spectrocopy by V.Formacek and K.H.Kubeczka-John Wiley and Sons.

1. Angelica seed oil
2. Anise seed oil
3. Bergamot oil
4. Cinnamon oil
5. Citronella oil
6. Coriander oil
7. Dwarf pine oil
8. Eucalyptus oil
9. Geranium oil
10. Lavandin oil
11. Lavender oil
12. Lemon grass oil
13. Lemon oil
14. Mint oil
15. Orange oil sweet
16. Peppermint oil
17. Petitgrain oil
18. Sage clary oil
19. Spike lavender oil
20. Star anise oil
21. Thyme oil

ANNEXURE 13

List of Books and Journals Suggested for Analytical Laboratory

Books:

1. Modern Practice of Gas Chromatography by R.L.Grob.

   Pub.: John Wiley & Sons Inc. 1977.

2. Analysis of Essential oils by Gas Chromatography and Mass spectrometry by Yoshiro Masada.

   Pub.: Halsted Press Book, John Wiley & Sons Inc. 1976.

3. Essential oil Analysis by Capillary Gas Chromatography and Carbon-13 NMR Spectroscopy by V.Formacek and K-H. Kubeczka.

   Pub.: John Wiley & Sons. 1982.

4. The Essential Oils. Vols. I-VI by E. Guenther.

   Pub.: Robert E. Kreiger Pub. Co. Huntington, New York. 1972.

5. Essential Oils Vols. I-III by B.M. Lawrence.

   Pub. Allured Pub. Wheaton, Illinois 60189 USA.

6. Merck Index. Pub.: Merck and Co., Inc. Rahway, N.J.07065, USA

7. Practical Organic Chemistry by A.I.Vogel

Journals

1. Perfumer & Flavorist (Bimonthly). Allured Pub. Corp. P.O.Box 318, Wheaton. Ill. 60189-0318, U.S.A.

2. J. of Essential Oil Research. Allured Pub. Corp, P.O.Box 318, Wheaton, Ill. 60189-0318 U.S.A.

3. Indian Perfumer (Quarterly), Essential Oil Assoc. of India, Dua Complex 24-Veer Savarkar Block, Shakarpur, Vikas Marg, Delhi-110092, India

Annex 14

Backstopping Officer's Technical Comments
based on the work of Mr. M.L. Maheshwari
DP/DRK/88/001/11-54

The expert has presented his activities and recommendations for further development of the essential oils industry in this report. His assignment for one month was the final activity of the project to complete the training of counterpart staff in quality assessment methods and development of standard specifications. The expert has repaired the GLC system to working conditions and carried out the duties assigned to him very successfully. The potential of new essential oils for local use as well as export has been highlighted. He has also supplied the project authorities with international standards (45), specifications of the Essential Oil Association of USA (49), Indian Standards (11) and 184 reference standard samples of essential oils, isolates and aroma chemicals. A set of gas chromatograms (59) were also gifted to the project authorities. The project counterpart staff can now continue to develop standards and conduct proper quality control of their products. The equipment recommended by the expert should be procured to expand the service facilities. The other recommendations of the expert should receive the urgent attention of the Institute and Government to increase the outputs of the Centre.