ADVANCES IN ESSENTIAL OIL INDUSTRY

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(BEING THE PROCEEDINGS OF SYMPOSIUM ON DEVELOPMENT OF ESSENTIAL OIL IN UTTAR PRADESH HELD AT KANPUR ON JANUARY 17—18, 1976)

Edited by
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Dr. Ram Krishan

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PREFACE

The papers presented by Research Scientists at the Symposium on "Development of Essential Oils in Uttar Pradesh" on January 17 and 18, 1976 at Kanpur are recorded in the present volume. This symposium was organised by

1. Ramganga Samadesh Kshetra Vikas Nigam Ltd., Kanpur
2. National Botanic Gardens, Lucknow
3. Central Indian Medicinal Plants Organisation, Lucknow
4. Harcourt Butler Technological Institute, Kanpur
5. Essential Oil Association of India, Kanpur
6. Directorate of Industries, U. P., Kanpur
7. Chandra Sekhar Azad University of Agriculture and Technology, Kanpur

An exhibition of natural and synthetic essential oils and perfumes was also held on this occasion. A unique feature of the symposium was that more than 70 farmers growing the essential oil plants like Rosa damascena and Jasmine from Hassyan and Barwana blocks of Aligarh district took active part in the discussion and presented their difficulties and achievements. The distillers and manufacturers of these raw materials also presented their problems and views as well as the marketing aspects.

The discussions led the participants to make some recommendations which were unanimously adopted and are given in the appendix. A committee consisting of the representatives of all the organisations who sponsored this symposium was formed to follow up these recommendations. Dr. Ram Krishan, Administrator, Ramganga Command was requested to be the convener of this committee.

We are pleased to record our grateful thanks to the staff of the sponsoring organisation, especially that of Ramganga Command and NBG without whose untiring efforts the symposium could not have been a success. We are also grateful to HBTI and CSA University for the facilities given to hold symposium and exhibition in the spacious auditorium of H. B. T. I. To the Lucknow Publishing House, Lucknow, we are grateful for their promptly publishing the abstracts of the papers in record time which were in the hands of the participants before the symposium was inaugurated by Prof. K. N. Kaul, Vice Chancellor, Chandra Sekhar Azad University of Agriculture and Technology, Kanpur. We are highly indebted to his active participation in the deliberations and discussions.

We also take the opportunity to thank M/s Today & Tomorrow, New Delhi, who acceded to our request to publish the proceedings. If there has been any delay in its publication or any errors or omissions, we apologise for the same as it was entirely due to us and none else. We hope this exercise will help in the development of essential oil industry in the State. This is just the beginning and needs a follow-up action in more energetic way.

L. D. Kapoor

Ram Krishan

SPEECH OF DR. RAM KRISHAN, ADMINISTRATOR, RAMGANGA COMMAND PROJECT, ON THE INAUGURATION OF ESSENTIAL OIL SYMPOSIUM

Mr. Vice-Chancellor, distinguished guests. I would like to avail of the golden opportunity for thanking you on behalf of the organisers of this Symposium namely - National Botanic Gardens, Lucknow; Central Indian Medicinal Plants Organisation, Lucknow; Essential Oil Association of India, Kanpur; Harcourt Butler Technological Institute, Kanpur; Directorate of Industries U. P., Kanpur; Ramganga Samadesh Kshetra Vikas Nigam Ltd., Kanpur and Chandra Sekhar Azad University of Agriculture and Technology, Kanpur for having extended your helping hands in making this venture of ours a great success. I would specially like to thank our farmer brothers who have gathered here to highlight their day-to-day problems in the cultivation of plants which contain essential and aromatic oils.

Many seminars, symposiums and meetings have been held from time to time to thrash out the problems of the essential oil industry. But hardly ever an active participation of the key man the farmer was sought. For the first time we are now making an attempt to bring together the farmer, the scientist, the industrialist and the administrator so that each may understand the viewpoint of the other. Only when problems are dealth with and solutions sought through a joint endeavour, progress is real and continuous.

In Uttar Pradesh, Farrukhabad and Aligarh districts have been the centres of essential oil industry from time immemorial. Luckily for the Ramganga Command Project all these areas come into its command for which the project is directly responsible for an integrated development.

With the development of pharmaceutical industry, the consumption of essential and medicinal oils have gone up manifold, but ironically the oil industry of the State has gradually deteriorated to an extent, that a few factories have almost closed down and the operating ones are on the verge of collapse. So where does the canker lie?

Primarily, I am of the opinion that lack of research, proper initiative to the flower and aromatic plant growers, inadequate attention on the part of government towards this particular industry has cracked its backbone.

There is ample scope, still, to exploit the potentials existing particularly in the State and throughout the country in general. Research work has to be intensified to promote the quality and packing of the aromatic oils. For this purpose at least two research stations should be established in Aligarh and Farrukhabad where the industry is mostly concentrated. On the other hand there should be quality control over the produce, for which a laboratory should be opened soon in the State.

There is a great potential for increasing exports of essential oil from the country. In this drive for export, Ramganga Command Project can give a great boost as the industry has great roads here and has great scope for branching and fruiting. Our aim has to be to increase exports and reduce imports.

I will not take much of the valuable time just now but once again I sincerely wish and hope that during the two-day programme a clear picture will evolve through the discussions, and give us particular direction to move towards. This would also go a long way in putting the essential oil industry of Uttar Pradesh on a firm footing.

INAUGURAL ADDRESS DELIVERED ON THE SYMPOSIUM ON THE DEVELOPMENT OF ESSENTIAL OILS IN U.P. HELD ON 17TH JANUARY, 1976

Prof. K. N. Kaul,
Vice-Chancellor,
Chandra Shekhar Azad University of
Agriculture and Technology, Kanpur

Friends, I am very much grateful to you for inviting me to inaugurate the Symposium on the Development of Essential Oils in U.P. I consider it a great honour and I am thankful to those friends who have remembered me to be with you and take part in your deliberations. I fully realize that my friends with whom I worked once as an active member in this field have taken this opportunity to draw me out of my seclusion which I have imposed upon myself in order to conserve my energy for more constructive work in the field of education and agricultural development.

When early man, living in the woods, discovered fire, he also discovered odorous principles in different plant material used for feeding the fire "Devta" AGNI. Relics of this early life are indicated in ancient Egyptian and Persian cultures and have survived in modern India in our Vedic Yaynas. The "Ahuti" (offerings to fire) always consist of aromatic plant material.

The use of aromatic material for warding off insects and for protecting skin in summer from prickly heat in tropics came in vogue during the development of "Ayurved". A large number of plant material in the form of aromatic roots, tubers, woods, leaves and flowers are mentioned in different early written "Nagantas" (Books on drugs), but nowhere distillation for oil or the active principle is mentioned, indicating probably absence of technique. It was probably in Persia, Egypt or Greece that crude methods of distillation were evolved as the Greek historian HERODOTUS (484-425 B.C.) as well as the Roman historian of Natural History Pliny (23-79 A.D.) and his contemporary Dioscorides, author of the Treatise "De Materia Medica" mentioned oil of turpentine and give a little information about methods of producing it, but they do not mention any other oil. It is only in the Persian and later in Arabic literature that preparations of aromatic distilled waters for medical purposes first appeared.

The Arabs took the art to Spain and refined a Spanish physician Arnaldo-D-Vilanova (1240-1311 A. D.) giving the first authentic description of the distillation of essential oils from where it spread throughout Europe in the later half of the 16th century. From 16th to 18th century, European physicians used medicated distilled waters and plant materials like cloves, mace, nutmeg, anise, spike and cinnamon, all obtained from the East were extensively used in their preparations. Often many substances that do not contain essential oils or furnish only traces of them were used such as gums and rainsins like, benzo in from Java, Sandarac and Saffron from Persia.

It was in the 17th and 18th centuries that a large number of French and German workers made valuable contributions into the nature of essential oils and include methods of distillation.

By the end of 18th century a nucleus of well organised community of industrial chemists appeared in Central Europe. The Arab merchants as maritime sailors procured the raw material for the development of this industry of the West from markets of the East in China, Indonesian islands, coastal India, Persia, South Arabia and Egypt.

Industry gave prosperity to Europe and in the late 19th and early 20th century, a large number of scientific societies, museums and botanical gardens came into existence in Europe and America. These societies and organisations supported the industry. Big companies like East India Company and Dutch, to cut down the Arabian Middlemen, sent their own emissaries to the East to capture markets.

This resulted in colonialism and ruination of eastern countries. Search for spices gave small or big Empires to the European nations.

The modern scientific world, developed only as a bye-product of all the industrial and commercial activities of the west in the east.

Out of evil often good comes, the east as a result of two world wars in the west inherited the scientific world and also freedom from the western domination.

It is now for us to utilize all the knowledge gained by men through the ages to build our country. We have unlimited resources in land, water and manpower. Only organised efforts are required to achieve our objectives.

In India, unfortunately the importance of the essential oil industry is not fully realized as most of us have got themselves involved in routine activities and have hardly any time left to contemplate on problems not directly connected with us. The word "essential"

is taken only to mean a derivative from "Essence" obtained from aromatic plants as an article of luxury. It is not realized that for our ancestors, it was not an article of luxury but an essential requisite for their daily social life. Prophet Mohammad had advised his followers to anoint themselves with some auto (Attr) before attending communal prayers.

Essential oils are not only used in cosmetics but in modern life they play a great part in our personal and social hygiene, for example, in perfumes and soap industries. They are also used in preparations of powerful external and internal antiseptics. Some of them are used in medicine also as analgesics for relieving pain and haemolytic, anti-enzymic, sedatives, stimulants, stomachics and anthelmentics.

Oils of spices are used for flavouring food to stimulate appetite. They are also used to mask objectionable of ours in working areas and in industrial products such as artificial leather, paints and rubber.

Time has come to attend to our basic problems. In U.P. we have extensive waste lands called "Usars" and erroded lands. These lands have enough subsoil water and during monsoon, we get more than enough water. Most of the aromatic plants require very little water for their healthy growth, and not very rich soils. They can be grown with very little efforts as they are not browsed by any cattle, goat or sheep or destructive birds, by our farmers as side crops to be collected by agents of small cottage industries.

Farming requires peaceful and contended mind which our farmers possess throughout the country. This is our real strength and wealth which have saved us throughout our history. In the present times they have special significance when the world is highly perturbed and spiritually unbalanced. A peaceful India can attract those who like to create a better world. In a peaceful atmosphere of our country scholars of the world would like to come and contribute their share for the advancement of scientific research and industrial development. We, in the past, have served the world in the west, now it would not be considered unfair if we expect the world to serve us in the east in the modern time.

With these words, I have great pleasure in inaugurating the Symposium on the Development of Essential Oils in Uttar Pradesh.

CONVENOR'S ADDRESS

It is my proud privilege to welcome the delegates who have come all the way to participate in this symposium on "Development of Essential Oils in Uttar Pradesh". I am particularly grateful to the delegates from the rose and jasmine growing areas who have made their presence felt here by taking such keen interest in the deliberations of this symposium. It is my duty to thank the different organisations, viz., National Botanic Gardens, Lucknow, Ramganga Samadesh Kshetra Vikas Nigam Ltd., Kanpur, Central Indian Medicinal Plants Organisation, Lucknow, Harcourt Butler Technological Institute, Kanpur, Essential Oil Association of India, Kanpur, Directorate of Industries, U.P., Kanpur and Chandra Sekhar Azad University of Agriculture & Technology, Kanpur, who have sponsored and organised this symposium which is unique in bringing together representatives of all the trades, right from farmers who grow aromatic plants, distillers, scientists, industrialists and administrators, on the same platform for the common objective, i.e. development of the essential oil industry in Uttar Pradesh.

In the interest of our farmers, distillers, perfumers and industrialists, it is absolutely necessary to expand essential oil industry in the State to build up our own economy as well as to earn foreign exchange by export of our products.

As we know the essential oil and perfume industry is facing stiff competition from synthetic perfumes in the world markets and if we do not take active steps in this direction, our essential oil and perfume industry will find it difficult to survive. I may suggest a few points which should be helpful in our Research and Development efforts:

1. To evolve improved strains or varieties of essential oil-bearing plants which have higher percentage of oil without sacrificing its quality.

2. To introduce some new aromatic plants growing wild in forests which have not been exploited for the essential oil today or procure some improved exotic strains of traditional aromatic plants for commercial cultivation at suitable places in the State.

3. To improve the distillation apparatus so as to reduce the cost of processing without deterioration in the quality of oil.

These steps will require a systematic experimentation and field work. If these problems are referred to NBG, CIMPO or CDRI, with the excellent facilities and expertise that these organisations possess, it would not be impossible for them to solve such ticklish problems.

I am particularly grateful to Prof. K.N. Kaul, Vice-Chancellor, Chandra Sekhar Azad University of Agriculture and Technology, Kanpur, who has kindly consented to inaugurate the symposium. I am sure under his inspiring leadership and dynamic personality, the deliberations of this symposium will boost the development of essential oil industry in Uttar Pradesh. I am personally grateful to my old friend Dr. Ram Krishan who first conceived the idea to hold the symposium here. I am sure with his keen interest in the subject and the areas that he commands today, the essential oil industry will flourish like other agricultural crops. I take the opportunity to thank the authorities of Chandra Sekhar Azad University of Agriculture and Technology and Harcourt Butler Technological Institute, Kanpur for providing facilities to organise the symposium and to hold the exhibition in this campus. I am grateful to the Essential Oil Association of India, Kanpur, whose members from Kanpur and Kannauj have come to take active part in the deliberations. Dr. S.C. Datta, Director, Central Indian Medicinal Plants Organisation, Lucknow, deserves special mention here for his commendable work in popularising Mentha cultivation in Tarai region which provided the much needed raw material for the menthol industry besides bringing prosperity to the farmers.

Last but not the least I am indebted to Dr. T.N. Khoshoo, Director, National Botanic Gardens, Lucknow, for the facilities he offered in organising the symposium and for his keen interest and advice from time to time. To the members of the Organising Committee and sub-committees for Publication and Exhibition, I offer my thanks for the ungrudging help and ceaseless efforts to make the symposium a success.

I take the opportunity to thank my colleagues in the National Botanic Gardens, Lucknow, for readily accepting the task to screen the scientific papers for publication both for abstracts and for proceedings.

For any lapse or inconvenience to the delegates for their board and stay, I as a Convenor, beg for their indulgence.

I thank you all for coming and taking part in this symposium to make it a success.

L. D. Kapoor
National Botanic Gardens
Lucknow

RECOMMENDATIONS OF ESSENTIAL OIL SYMPOSIUM HELD AT KANPUR ON 17th & 18th JANUARY 1976

1. Recommended that the Research Centre at H. B. Technological Institute, Kanpur be revived for development of Essential oils industry of the State. The Centre may run a training course for distillation and analysis of essential oils and also analyse the samples on concessional rates.

   Attention - Secretary, Industries

2. Recommended that there should be more detailed study on the chemistry of essential oils and on the recovery of essential oils on pilot plant basis, with a view to increasing the quality and quantity from improved distillation units.

   Attention - Director General, C.S.I.R., New Delhi.
   Secretary, Industries, U.P. Government
   Director, H.B.T.I., Kanpur

3. There should be techno-economic survey of the flora to discover new indigenous essential oil plants and introduction of exotics for cultivation on semi-commercial and commercial scales.

   Attention - Botanical Survey of India, N.B.G.,
   C.I.M.P.O. and Botany Departments
   of Universities of Lucknow, Agra, Kanpur,
   Garhwal, Kumaon, Banaras Hindu University
   and Meerut.

4. The experimental stations for essential oil cultivation and extraction be established in the districts of Aligarh and Ferrukhabad, where multi-cultural trials of genuine plants should be undertaken and propagating material or seeds may be produced and distributed. Economics of cultivation and processing of essential oils should also be studied and published.

   Attention - Chandra Sekhar Azad University of
   Agriculture, Kanpur and Medicinal plants
   co-ordination cell of I.C.A.R.

5. Recommended that the Chandra Sekhar Azad University of Agriculture and Technology should take up pilot culture studie of Usar land, Khadar areas, marshy soils and along the banks of canals for growing khas (vetiver), citronella, mentha and other suitable plants. It should also open farms in the Ramganga Command for the supply of seeds of such plants to the farmers.

Attention - Chandra Sekhar Azad University of Agriculture and Technology, Kanpur

6. Resolved that the forest department of the State should also take up cultivation of aromatic plants in the vacant areas of the forests. A survey of the aromatic growing wild in the forest should also be conducted.

Attention - Chief Conservator of Forests.
Secretary, Forest, U.P. Government

7. Forest department should try to take up the cultivation of sandalwood in Bundelkhand area, which is said to be suitable for its growth.

Attention - Chief Conservator of Forests.
Secretary, Forest, U.P. Government

8. Export Corporation of U.P. and All India Export Promotion Corporation may take active steps to boost the export of essential oils, atars and 'Aggarbaties' from U.P. and advise the suppliers about the market demands in foreign countries. An essential oil corporation may be formed to purchase essential oils from the distillers for marketing in the country and outside.

Attention - Export Corporation of U.P.
Export Corporation in Delhi and
Essential Oil Industries, U.P.

9. Efforts should be made to extract and market the essential oil from the leaves of Skirmmia (a common shrub growing wild in the hilly regions of U.P.)

Attention - Forest Department of U.P.
Director of Industries, U.P.
Kanpur Hill Development Corporation, U.P.

10. Resolved that the H.B.T.I., Kanpur should impart training to farmers and other interested persons in the essential oils distillation process. The Institute should also have facilities for testing the samples of essential oils sent by the industry at concessional rates.

Attention - Director of Industries, U.P.
Secretary, Industries, U.P.

11. Research should be initiated to design and produce presentable containers for attars and other essential oils meant for export.

Attention - Director, Indian Council of Agricultural Research
Council of Scientific and Industrial Research, New Delhi
Hercourt Butler Technological Institute, Kanpur

12. The State financial corporation of U.P. and the nationalised banks should provide grants liberally to the cultivators and distillers of essential oil plants.

Attention - State Financial Corporation, Nationalised banks and Essential Oil Association of India.

13. Ramganga Command Project may set up mobile distillation units in areas where cultivation of essential oil plants is concentrated for distillation of oil to promote it as a cottage industry.

Attention - Ramganga Command Project, Kanpur

14. A cell be created in the Directorate of Industries to watch and promote the development of Essential Oil Industry in Uttar Pradesh.

Attention - Director of Industries, U.P.
Secretary, Industries, U.P.

15. A high power advisory council be set up by the U.P. Government with the Minister of Industries as Chairman to facilitate development of essential oil industry, help in fixing prices for raw materials, to boost export of essential oils and to rationalise imposition of sales tax and excise tax structures.

Attention - Secretary, Industries, U.P.

16. Resolved that sales tax on attars be reduced from 12% to 5% for encouraging the development of essential oil industry. Purchase tax on raw materials needed for essential oil industry should be abolished.

17. Central Indian Medicinal Plants Organisation should set up extension services in the Ramganga Command Area for the development of essential oils as they have done in tarai areas for Mentha arvensis.

    Attention - C.I.M.P.O. and Ramganga Command Project.

18. National Botanic Gardens, Lucknow and Central Indian Medicinal Plants Organisation should try to evolve new improved cultivers of essential oils for cultivation.

    Attention - National Botanic Gardens, C.I.M.P.O. and Ramganga Command Project.

INTRODUCTION

The essential oils and perfumery industry is an important small scale industry of Uttar Pradesh, manufacturing oils like Sandalwood, Palmarosa, Cederood, Vetiver, Peppermint, Celery, Attars, Perfume waters, Hair Oils and isolates like Menthol, Thymol, Geraniol, etc., not only for internal demand but for export as well. Many of the oils like Sandalwood, Kewda, Palmarose and Vetiver and sizable quantities of "attars", rose water are exported to foreign countries and thus earn valuable foreign exchange.

India's export trade of essential oils amounts to Rs 4-5 crores annually which comprises Lemon grass, Palmarosa, Vetiver and Sandalwood oils. The import statistics reveal that the essential oil of Bergamet, Citronella, Geranian, Lavendar, Orange, Pachouli and Peppermint are still imported in bulk quantities.

The topography of Uttar Pradesh has a variety of agroclimates and all types of plants from tropical to temperate habitat can grow under the varying climates in this state. Plants like Lavender, Citronella, Bergamet, Mints, Rosemarinus etc., can be grown in suitable areas for the production of essential oils which are otherwise imported.

The major market for essential oils has been mainly concentrated in Kannauj and Kanpur but now the trade is facing a keen competition from the synthetic perfumes in the foreign markets. The problem of facing the competition has been engaging the attention of the research scientists and manufacturers for quite some time. The economic production of these essential oils in bulk needs the improvement in distillation process and production of raw material at lower cost. The foreign markets prefer to have alcohol-based perfumes rather than oil-based and it is for the research scientists and the government to provide the perfumery grade alcohol which is not available at present to the perfumery industry.

To focus the attention of the scientists, industrialists, farmers and administrators, a symposium was held at Kanpur on 17th and 18th January 1976 wherein all of them participated and explained their achievements and difficulties. During the discussions some recommendations were made which need to be followed up. This volume is the record of the proceedings and recommendations and have been edited by the undersigned for the benefit of all who are interested in the essential oil production.

Fortunately, in Uttar Pradesh, there are three research laboratories of Council of Scientific and Industrial Research, which are directly or indirectly associated with the essential oils research and development and with their collaboration and with the help of the Ram Ganga Command administration, the cultivation of essential oil-bearing plants like Rose, Jasmine, Citronella, Lemongrass, Vetiver, Lavendar, Peppermint, etc., can be extensively cultivated and processed. It was gratifying to record that for the first time in a Symposium of this type the growers and distillers of Rose, Jasmine and Peppermint plants and the perfumers and traders dealing in the formulations and marketing took part in the discussions on the same platform. Apart from that the administration of Ram Ganga Command, National Botanic Gardens, Central Indian Medicinal Plants Organisation, Harcourt Butler Technological Institute, Chandra Sekhar Azad University of Agriculture and Technology, Kanpur, Essential Oil Association of India and Director of Industries, U.P., took active part in the deliberations.

It would be seen that this industry of essential oil and perfumes can be developed on cottage scale but there should be one co-ordinating body or clearing house for overall guidance in standardization and marketing. The export market should be built up on scientific lines and a strong wing for market research should be developed by the industry.

Dr. L.D. Kapoor
Scientist
National Botanic Gardens
Lucknow-1

Dr. Ram Krishan
Administrator
Ranganga Samadesh Kshettra
Vikas Nigam Ltd.
Kanpur-2

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PROBLEMS OF ESSENTIAL OIL INDUSTRY

G. N. Gupta
Essential Oil Association of India
H. B. T. I., Kanpur-2

Essential oil industry is one of the small-scale industries of the State and is being carried out from Vedic period. Similar to other small-scale industries, it also has agricultural, manufacturing and marketing problems.

Any person before starting any industry is interested to be familiar with its economics alongwith the availability of raw materials, process of preparation or manufacture, its packaging and marketing etc.

As regards the essential oil industry, farmers do not know exactly the sources of availability of suitable type of raw or planting materials, names of fertilizers or manures, their quantities to be applied per unit area, irrigation frequencies, diseases, insecticides and pesticides for protection of plants, optimum time for harvesting, yield of oil by distillation or extraction, because they differ from plant to plant. Since many farmers do not possess distillation equipment, they have to sell their planting materials to the distillers, sometimes at very low cost.

It is, therefore, suggested that there should be some agency or society, which may provide practical information on the above points. It should also have nursery to supply improved type of planting materials, fertilizers, manures and insecticides etc. to farmers. Distillation equipment may also be installed at central places in order to distil the planting materials of growers within a radius of 5-10 miles. If possible, the finished products, i. e., oils, may also be purchased by the society or agency at some fixed rate and marketed. The farmers may also be awarded bonus, if the agency gains good profit. By this means, the farmers would gladly take up the cultivation of perfume-bearing plants and thus increase their income and decrease unemployment.

Small growers face the difficulty of irrigating their fields, because sometimes water from canal is not available. It results in the dryage of crops causing great loss to cultivators. It sometimes happens at Hassayan and Bermana - the centres of rose flowers in Aligarh district. Consequently the prices of rose flowers are increased. On the other hand, if the crop is good, the prices are decreased. The price of Mentha arvensis oil increased considerably last year due to low yield of crops because of failure of rains.

The distillers, on account of the variation in prices, cannot make forward transactions, because for export, the quantity and the price of the oils are to be settled beforehand.

The quality of oils also differs at places besides malpractices. There should be a laboratory to examine the oils at nominal rates. The rates charged at present in testing laboratories are exorbitant and beyond the means of small growers or distillers. The dealers also face this difficulty in making purchases or selling their products.

The big distillers also face difficulties of coal and power, because they do not get regular supplies of coal and power continuously, thus production is affected considerably at times. As the labour is to be paid, thus the cost of production of the products increases.

To solve the difficulties of growers and distillers there may be some institution, which may guide them in their venture and arrange the training of persons.

Much of the above work was being done at H. B. T. Institute, Kanpur, from 1949 to 1966, but owing to closure of the Essential Oil Scheme in 1966, the cultural fields and distillation equipment and laboratory have been discontinued. Several persons had started the cultivation of Mentha arvensis, Mentha piperita, Palma rosa etc. A new improved type of still was also designed, which was adopted by some distillers. New techniques were suggested for the preparation of rose and Khus oils. Essential oils from several well-known flowers, e.g., rose, Chameli, Bela, Juhi, Moulsari, Kadamb, Kewra were prepared and examined. Essential oils from vetiver, Acorus calamus, Ajowan, Caraway, Cyperus scariosus (Nagarmotha) and Laurus nobilis (Sugandh Kokila), Ocimum besailicum, Ocimum kilimandscharicum, Mentha arvensis and Mentha piperita were also prepared and examined.

Besides these, interested persons were also trained.

SOME ESSENTIAL OILS OF INDIA

V. N. Vashist
Regional Research Laboratory
Jammu Tawi - 180001

India reigned the world market in essential oils and perfumes. Indian perfumers were reputed for their skill in the art of extraction of volatile oils and blending perfumes. But the position has reversed because of the status quo in the Indian Perfumery Industry and rapid advance of this industry in foreign countries. Our exports have declined in quantity and imports have become fat (higher amount is due to inflation). In fact India only exports three essential oils in any measure, viz, sandal wood oil, lemon grass oil and palmarosa oil. But our imports of about Rs 3 crores a year are continuing. The imported oils are Citronella, Clove, Peppermint, Spearmint, Cinnamon leaf, Geranium, Lavender, Anise, Lemon, Orange, Petit grain, Bergamot, Cananga, Cajuput etc.

It is a sad affair that only half a dozen of the aromatic plants are being systematically cultivated in the country whereas more than one thousand species of Indian flora are reported to contain odiferous materials. India is one country with all sort of climatic and ecological conditions. Hence it is possible to domesticate some of the most sought after essential oil bearing plants and enhance the production of other oils so as to cut down imports and regain our position in the foreign markets respectively.

I would now like to discuss some essential oils which are responsible for earning foreign exchange and helping in reducing our imports.

1. *Sandal Wood Oil*

It is the most important oil that India has been traditionally exporting to North America, European countries and Japan. The Indian exports of this commodity command 90 per cent of the world trade and fetch about Rs 3 crores in hard currency annually.

The UNIDO survey has emphasised that even though no competitor of India is likely to emerge in the near future, nevertheless, it is important to take steps to retain this position. The Mysore Government Sandalwood Oil Factory has done a pioneering job in setting standards of quality and presentation. Indonesia's contribution in this field is just a small fry. Hence the sandal wood oil world market can be regarded as a stable one in favour of India for foreseeable future. Therefore, this country should be able to maintain her exports around 100-110 m.t. per annum. The problem of the spike disease of sandal wood should be tackled on war footing basis.

2. Cymbopogon Oils:

A. *Cymbopogon flexuosus* or lemon grass oil is the leading oil of the family and for India the second best oil for export. But an aggressive competition is posed by Guatemalen plantations (citral content 85-88% as compared to 75-80% in India's oil) and with a further possibility of China entering the world market. From more than 1000 m.t. in 1962, India's annual export of the oil plummeted down to mere 200 m.t. in 1974. Since then no signs of increasing the export have been witnessed. That this should happen to a raw material in which we were proud to have worldwide monoply is a matter of sad comment. The total production of this oil is about 800 m.t. as against the requirement of about 1500 m.t. There is a big scope for its export if quality of the oil is improved. Regional Research Laboratory, Jammu has developed a hardy variety called RRL-16 "Jammu Lemon grass" (citral content 75-80%). This variety is very suitable for cultivation in Punjab, Haryana and U.P. Many prospective growers have already started cultivation of the new variety.

B. *Cymbopogon martini* var. *motia* yields oil of palmarosa, the third main oil being exported from the country. The exports are about 20-25 m.t. valued at Rs 0.35 crores. The best quality of the oil is obtained from wild growth in the forests of Maharashtra and M.P. But dependence on forest resources is a short term view. Better varieties of the cultivars are available with CIMPO, Haldwani. Moreover, the regular cultivation will ensure a good quality of oil thus enhancing foreign exchange earnings.

C. *Cymbopogon winterianus* is the source of famous java citronella oil. Till recently this oil used to be imported. Thanks to the enterprising growers of Assam that its cultivation has spread in many tea estates. Further stimulation was provided by the Regional Research Laboratory, Jorhat which has developed the scientific and commerical expertise for its cultivation. U.P. has also taken up its cultivation with the help of CIMPO while in South India, Bangalore Centre of CIMPO has been helping the

growers. The country's present requirement is estimated at about 200 m.t. and might touch a figure of 400 m.t. by 1980.

In addition to these oils, two new varieties of Cymbopogon viz. RRL-14 and RRL-59 developed by RRL, Jammu have big scope. Cultivation of these varieties should be seriously taken up.

3. Oils of Mentha Species

A. *Mentha arvensis* Linn. var. *piperascens* Holms. (Japanese mint) has come a long way to attain its present status. Credit for its success goes to RRL, Jammu where a team of scientists led by Dr. L.D. Kapoor did stupendous amount of work to domesticate the plant in India. CIMPO has done the major extension work with the result that U.P. is leading in its cultivation. Total production of the oil is expected to be over 200 m.t. valued at Rs 3 crores at current price. This has given boost to the production of menthol. Fifteen new industries have started producing menthol crystals based on the technology developed by RRL, Jammu. Import of this oil into the country has almost stopped.

B. *M. piperita.* M. piperita yields the well known oil of peppermint. It is an important oil used in perfumery and flavouring industry. RRL, Jammu and CIMPO, Haldwani have done pioneering work for establishing the plant. The demand of this oil is estimated at about 30 m.t. valued at Rs 0.75 crore. This oil is more expensive than the Japanese mint oil. There is immediate need for extension work in this regard as the actual production is far less than the projected requirement.

C. *Mentha spicata.* Popularly known as oil of spearmint and is equally important in the flavouring industry. The work on this species has not borne fruit and intensive effort is needed to make it a success. There is every reason for its success. The present requirement is 5 m.t. valued at Rs 8 lakhs.

D. *Mentha citrata.* This is a recent entry to the group of natural essential oils. Oil from Jammu grown plantation has been well received in the perfumery market. The major components of this oil are linalool and its acetate (both about 70-80%). Lot of interest has been generated in its cultivation. Planting material is available with RRL, Jammu. The future annual demand for this oil is estimated at about 10 m.tonnes.

4. Other oils

It is true that cultivation of Japanese mint and Java citronella is fast expanding. But there are number of oils, other than

mentioned earlier, which need to be produced on large scale. The cultivation of Geranium, Lavender, Eucalyptus citriodora, Patchouli, French basil, Davana, Dill, Costus roots, Vetiver, Celery and Ylang Yland need urgent attention and are feasible in India. To cope with India's need in the sphere of essential oils 100,000 acres of additional land are needed. There is no dearth of land with the state governments. Incidently, this will provide new avenues for employment to both educated youngmen and farmers. Such would-be-plantations should be coupled with big and efficient distillation stills to give improved yields, thus ensuring higher returns to the growers. In addition, the production of Indian top oils needs to be increased manifold (not at the cost of quality) to meet the challenge posed by and to take an edge over some African countries and China. Table I gives an idea of our exports of major oils with the fond hope of adding half a dozen more oils by 1977-78. Table II details the present and estimated future annual requirement of important essential oils in India.

Marketing

I personally feel that not only the cultivation or production of various essential oils are the only important factors in this industry but marketing and salesmanship also contribute equally. Whereas this is being done in the case of lemon grass and sandal wood oils by State Trading Corporation of India and the Mysore State Government respectively, there is no proper agency in the country for most of other oils. Consequently, small exporter does not know the quality requirements of his product or he does not know the right buyer abroad. This affects the overall reputation of the industry. Thus there is a need for a better organised system for maintaining contact with 30 to 40 'trend setting international houses' and foreign brokers. In addition, national and international standards of quality should be adhered to strictly. The large scale production of various essential oils will fail to yield the results in case proper quality and other standards are not maintained. The following areas are recommended by achieving the marketing objectives:

1. India should embark upon production of essential oils as mentioned in the body of the paper both for import substitution and enhancing the exports. For exports, additional quantities of Palmarosa, Lavendar, Geranium, Vetiver, Patchouli, Ylang ylang, Cedar wood oils should be produced. To curb imports, India should produce more of Citronella, Lemon, Orange, M. piperita, Lavender, Cinnamon leaf, French basil, Anise, Geranium, M. spicata and M. citrata oils.

2. The State Trading Corporation of India or similar body exclusively meant for export of essential oils should be made responsible for the oils produced in India.

3. The quality and flavour evaluation should be done with the help of experts in the buyer countries.

4. The brokers should be directly contacted and marketing and salesmanship should be modernised.

5. Task forces for the production of various oils should be set up by involving national laboratories, industrialists and other experts in the trade.

6. All State Governments should make laws to utilise unused land and encourage growing of such essential oil bearing plants as are recommended by task forces.

It is my firm opinion that this country can take a lead from her competitors. Our exports of essential oils can be doubled. What we require is the "Will" to increase production and coordinate efforts of various agencies to fulfil the need of the hour. I take this opportunity to thank the organisers for extending invitation to me to participate in this Symposium.

TABLE I

*EXPORTS OF ESSENTIAL OILS (Crores of Rupees)

Name of Oil	1970-71	1971-72	1972-73	1973-74	1974-75 (estimated)	1975-76 (objective)
1. Sandal wood	2.45	2.61	2.50	3.50	3.60	4.00
2. Lemon grass	0.78	0.79	0.80	2.10	2.00	2.00
3. Palmarosa	0.25	0.25	0.26	0.40	0.35	0.50
4. Petiver	0.02	0.02	0.02	0.03	0.03	0.02
5. Geranium	-	-	-	-	-	0.45
6. Lavender	-	-	-	-	-	0.15
7. Patchouli	-	-	-	-	-	0.30
8. Ylang Ylang	-	-	-	-	-	0.04
9. Cedar wood (deodar)	-	-	-	-	-	0.20
10. Miscellaneous oils	0.26	0.27	0.25	0.27	0.30	0.30
Total	3.76	3.94	3.83	6.30	6.28	7.96

* India exports essential oils to: Australia, Bulgaria, Ceylon, Cuba, France, Germany (East), Germany (West), Ghana, Hong-Kong, Hungary, Italy, Japan, Nepal, Netherland, New Zealand, Nigeria, Spain, Sudan, Switzerland, Thailand, Arab Republic, United Kingdom, U.S.A., U.S.S.R., Yugoslavia, West Indies etc.

TABLE II

THE PRESENT AND FUTURE ANNUAL REQUIREMENTS OF IMPORTANT ESSENTIAL OILS

Oil	Present Qty. (tonnes)	Requirement value (Crores Rs.)	Future Qty. (tonnes)	Requirement value (Crores Rs.)	Likely locality for cultivation
1	2	3	4	5	6
1. Mentha arvensis	200	3.00	300	4.50	J&K, U.P. (Tarai area & adjoining districts), Punjab
2. M. piperita	30	0.75	60	1.50	J&K, Punjab, U.P., Bangalore
3. M. spicata	5	0.15	10	0.30	J&K, U.P., Nilgiris
4. M. citrata	-	-	10	0.12	J&K, U.P., Nilgiris, Darjeeling, Assam.
5. Sandal wood	150	3.60	150	3.60	
6. Lemon grass	700	3.50	1500	7.00	Kerala, U.P., Assam, J&K (for Jammu Lemon grass)
7. Palmarosa	35	0.35	50	0.50	U.P., M.P., Maharashtra, Assam
8. Cedar wood	30	0.09	50	0.15	
9. Java citronella	200	0.14	400	0.28	Assam, U.P., M.P., Maharashtra
10. Lavender	15	0.60	20	0.80	Kashmir, H.P.
11. Eucalyptus citridora	15	0.09	50	0.30	J&K, U.P., S. India, Assam
12. Cinnamon/Clove oil	40	0.36	100	0.90	Kerala, Assam
13. Lavendine	5	0.07	10	0.14	Nilgiris
14. Patchouli	20	0.20	25	0.25	Bangalore, U.P., Assam
15. Geranium	10	0.50	15	0.75	Nilgiris, Assam
16. Citrus peel	70	0.28	100	0.40	M.P., Coorg, Assam
17. Ajowan	5	0.03	10	0.06]	Central India
18. Anethi	20	0.12	30	0.18]	
19. Vetiver	8	0.16	12	0.24	Kerala, Mysore
20. Miscellaneous (Davana Costus, Celery Nutmeg & E. globules etc.)	These oils are also in demand in home and abroad and can be good source of foreign exchange.				

PERFUMES IN PERIL

J. N. Kapoor
Jagat Aroma Oils Distillery, Kannauj

Kannauj, the town of perfumes, is situated on the confluence of River Ganga, Ramganga and Kalinadi in the State of Uttar Pradesh. The fertile soil, and river water were helpful in cultivation of flowers in this region. There was regular trade from India to Middle East and Western countries in distant past. Perfumers of Kannauj have endeavoured hard to maintain the art and science of perfume production.

Perfumes are used to mask the bad odour of various bases of cosmetics. They are used to make the atmosphere pleasant. Perfumes are classified as luxury. True, it is not a must. It has no direct functional activity. Indirectly it has far reaching effect. It makes environments pleasant, mind in a happy mood. It stimulates feeling of happiness and satisfaction. The increased population is continuously polluting atmosphere, land and water, which nature is unable to counteract, and hence man made perfumes are needed to fight this nuisance.

The perfumery industry is well established in U. P. and mostly localised in Kannauj. Sandalwood oil in modern Distilleries is produced in Kannauj and Kanpur. Production of Attars is mostly done at Kannauj and Lucknow. Various other spice oil are being added further and further. Recently Pepermint oil has been taken up in big way in U. P. particularly Tarai Region.

Our classic perfume is Attar. It is blend of Sandalwood oil and various natural flowers and herbs. Formerly attars were directly used on body as perfume. But now our biggest consumers are Zarda, Snuff and Agarbatti manufacturers. The important attars being Gulab, Kewra , Hina, Motia and Khas. Curious enough " MITTI ATTAR " is also made from baked clay materials. The natural attars are better than the various synthetic products. They may be applied direct to body without any irritation. It can

be taken internally in various food products without any harm. It has lasting odour. In its production various raw materials, particularly Sandalwood oil flowers, herbs, gums are used. It envolves art of blending. Proper marketing after production is equally necessary. High cost of raw materials require large finances, scientific development require modern technology, continuous research in production methods, and cultivation of new natural products.

But now this industry is hard hit;unless immediate measures are taken, it is doubtful if this could survive in Uttar Pradesh.

The basic material for Attar is Sandalwood oil. And this is being produced in U. P. by importing Sandalwood from Tamil Nadu and Karnataka States. Karnataka has already stopped selling Sandalwood which had supplied nearly 25 %. Now the only source is Tamil Nadu. This State is also thinking of stopping sales of Sandalwood and utilising it for their new large factory proposed to be set up. This will ultimately result in closing all the Sandalwood distilleries not only in U. P. but in other states also. All these distilleries are in small scale sector, which mean the establishment of monopoly large scale factory at the cost of nearly 12 small scale distilleries.

Cultivation of flowers: Rose, Bela, Chameli, and Mehdi are important flowers cultivated in U. P. But the area under cultivation is shrinking, due to sudden fall and rise of the price of flowers and also other crops. The proper manuring, weeding, lack of planting material, lack of newer methods of cultivation involves grower. Suitably sturdy strains are required for economic production. Soil testing and selection of suitable soil for particular plants is needed. The proper guidelines for cultivator are needed most. Besides these, other new plants at selected places are to be introduced. Rose flowering lasts only for a month and other suitable strain which give flower for longer duration will be welcome by cultivators. Due to clearance of forests, Khus is being wiped away.

The industry also uses some of the imported items like Nakhala, Gum Benzoine, Saffron, Nutmeg and Clove but these are not allowed to be imported for this industry and hence purchased at higher costs in open market.

For the production of Attars, we use mobile units known as Deg and Bhapka. They are versatile. But these apparatus will like to invite the attention of our chemical engineers so that there may be lesser fuel consumption, less loss of products and also the uniform quality control, which is not possible in the existing "Deg". Besides distillation, other methods of extraction by

solvents, and initiative of new generation of perfumers. Joint participation of the Government and private entrepreneurs may be a good idea in this direction, which may serve as model for other manufacturers.

Producers of Attars and essential oils are unable to maintain individual laboratories for quality control. The buyers are at fix as how to judge the quality of products. Field laboratories will help in quality control and sales promotion.

Our packing of attars does not have sales appeal due to lack of attractive packing, either for display or for transports. Various controls on packaging material are hinderance to small artisan who makes the containers. There is much leakage and breakage in transit, to the annoyance of buyers.

In order to compete with other similar products, our cost of production and selling price should be lower. But unfortunately the Government always put the heaviest Sales Tax on these products. Nearly 30% of the price is increased due to various Sales Taxes on raw materials and finished products. They always classify it as luxury while it is not so as stated above. Entirely its production is on small scale, and an important raw material for Tobacco and Incence industries. Revenue should not be the only consideration for fixing various taxes. As a matter it should also be borne, how far an industry can absorb the burden. Presently the burden is too much. The procedurs for tax realisation are too complicated and some of the small producers have stopped the production.

Some people are manufacturing Menthol on small scale, and they have to compete with large scale producers. But the rate of excise duty is same on both. Due to lower recovery in small scale, these producers find difficulty to sell in competition.

Although it is old industry in U. P., earning much revenue, giving jobs to thousands of people, but there is no institution where our coming young educated entrepreneurs could get systematic training with scientific background, either in cultivation or production of various new perfumery products. At H. B. T. I., Kanpur there was short term course, but that too was stopped.

We take this opportunity of inviting the attention of concerned authorities to study our problems and take immediate measures for redressing. Particularly the taxation on sales is the biggest burden on this industry and unable to bear it. We may also request our scientists and research workers to convey their findings directly to cultivators or manufacturers. Let the results of laboratories be utilised for the betterment of the industry. And ultimately I will request our fellow manufacturers to have broader and modern outlook and be prepared to adopt the recent developments in in technology and marketing, and to move with the consumers' demand.

PRESENT STATUS OF RESEARCH AT LEMONGRASS RESEARCH STATION, ODAKKALI, KERALA

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INTRODUCTION

Kerala can be clearly divided into three different agro-ecological regions viz., High ranges, Middle region and Coastal area. High ranges and Middle region are rich in aromatic herbs and plants and it has been attracted by the foreigners like Portugese and Romans, in the past, who came to the shore of Kerala as regular merchants.

Odakkali Station is situated in the middle region of Kerala. It is having an elevation of 66 m from sea level and the average annual rainfall is 2900 m with 160 rainy days. 80% of the rainfall occurs during the four monsoon months, June to September. July and August months are having the highest number of rainy days with heavy down pour. The annual average maximum and minimum temperatures are 28°C and 24°C respectively. The highest maximum and minimum temperature in a day will not usually exceed 33.5°C and 19.5°C respectively. There is a prolonged dry period from December to April in a year.

The Station was started in 1951 as 'Lemongrass Breeding Station' under the industrial department of the erstwhile Travancore-Cochin State. It was transferred to the Department of Agriculture in 1954 and the name of the Station was changed to 'Lemongrass Research Station'. Soon after the formation of Kerala Agricultural University in 1972, the station was transferred to the University. The proposal for changing the name of this station to 'Research Station on Aromatic and Medicinal Plants' in order to take up studies on medicinal and other aromatic plants of economic importance, is now under the consideration of the University.

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The Station now carries out investigations on botanical, agronomical and biochemical including distillation aspects of various essential oil-yielding plants with special reference to the East Indian Lemongrass (C. flexuousus) for which Kerala is having monopoly in the production of oil.

WORK DONE

One research project each in Lemongrass and Vetiver was implemented successfully with the joint financial aid of ICAR and the State Government from the 2nd to 4th Five Year Plan. Notable achievements were made from these studies. Salient findings so far obtained on various aromatic plants are given below.

Lemongrass (C. flexuousus)

Botanical:

1. A Germplasm Bank was built up with 439 types collected from within and outside the State.

2. Floral studies show anthesis in the plant takes place by 3 A.M. and continues till 10 A.M., the maximum activity being from 5.30 A.M. to 6.30 A.M. Receptivity of stigma is found to be a maximum for one hour after flower opening.

3. In the breeding trial, hand emasculation and pollination are not found to be practical. The hot water treatment to incapacitate the pollen is also not found to be a perfect method.

4. One improved type viz., OD-19 has been evolved by selection. It has out-yielded all the local types in oil yield by 94% and given high citral percentage (85 to 90%). The demand for the seeds of this variety during the last year was for 5000 kg.

5. New Schemes. A replicated trial with plants raised from irradiated OD.19 seeds, has been laid out during this year. A scheme namely 'Induction of mutations and polyploidy on variety OD.19 using chemical metagenesis has been forwarded to CSIR for getting grant-in-aid.

Agronomical:

Package of practices has been standardized - N.P.K. trial showed that the application of fertilisers did not commensurate the cost of production of oil. Micro-nutrients also did not increase the yield of oil significantly though copper gave the maximum grass and oil yield. Studies on crop removal of major nutrients and on diseases are the other items to be taken up, during the next year.

Vetiver (Vetiveria zizanioides)

Out of the six varieties including North Indian types tried, a Malabar variety viz., Nilumbar was the best with regards to oil yield. Package of practices and processing technique have been standardized.

Palmarosa (C. martini var. Motia)

Six exotic types including Amaravathi have been collected and planted in Germplasm Bank. The variety viz. 'Amaravathi' was introduced ten years ago from Maharashtra and from its performance at this station as well as in cultivators' fields, it can be now recommended as a rainfed plantation crop in the plains of Kerala. Since the price of the oil is very attractive and is, more or less steady, when compared to Lemongrass oil, there is a great enthusiasm among the growers for its cultivation and the crop area is increasing year by year. A new scheme for conducting comprehensive studies on all aspects of this crop has been submitted to ICAR for financial assistance. Fertiliser trial and spacing trial are the experiments now at hand. Moreover, a few seeds and slips of the variety 'Amaravathi' were treated with gamma rays, and the plants grown out of it are under close observance.

Eucalyptus (E. citriodora)

This species is so far grown in high altitudes in Kerala. But the performance studies conducted at this station for the last few years, have shown that it can be successfully grown in the plains also as a rainfed crop. The oil produced at this station is acceptable to the industry. The Citronellal content in the oil ranges from 80% to 90%. Systematic studies on the agro-techniques and distillation aspect will be started from the next year onwards.

Cinnamon (Cinnamomum zylanicum)

It is grown at this station for extracting leaf oil. The oil produced is of good quality and is readily acceptable by the consumers. Studies like foliar application of urea, stage of harvest etc., are the items proposed to be taken up on this crop.

OTHER AROMATIC PLANTS

Japanese mint (Mentha arvensis)

Studies have shown that it can tolerate neither the heavy rain during the monsoon months nor the prolonged dry period prevailing from December month.

Sweet Basil (Ocimum basilicum)

Studies on the performance of sweet basil conducted for the last two years, have shown that it cannot be profitably cultivated under the conditions prevailing at this station. Only one harvest could be obtained from the plant while it is reported to have three harvests in North India.

Ceylong & Java Citronella (C. nardus and C. winterianus)

Ceylon citronella is cultivated at this station for the last few years and it is found to be successful under rainfed condition though its oil fetches less price compared to that of oil from Java types. Plants of Java types (Java 1 & 11) introduced at this station from CIMPO, Bangalore during last year and it is under study.

STUDIES ON DISTILLATION TECHNOLOGY AND BIOCHEMICAL ASPECTS

There is a steam distillation unit and a biochemical laboratory attached to this station, where several studies on processing and chemical analysis are being carried out. Post-harvest studies conducted on distillation materials and studies on storage of oil have given several useful information of economic importance. For want of sophisticated equipment, all the physico-chemical properties of various oils could not be estimated now. Only aldehyde and alcohol estimations are done in the laboratory at present. The laboratory will be soon developed fully for taking up more detailed studies on various oils.

CONCLUSION

The trend of the studies carried out so far at the Lemongrass Research Station, Odakkali, Kerala, on various aromatic plants, indicates that there is immense scope for further improvement in their productivity and adaptability. Area development approach on different agro-ecological regions of Kerala will provide impetus for the growers to expand the crop area under the suitable aromatic plants of economic importance. Hence it is proposed, now, to start investigations in two more centres, one at Wynad representing high ranges and the other at Trivandrum representing the coastal area.

INTRODUCTION OF MENTHA SPECIES - A BREAKTHROUGH IN THE ESSENTIAL OIL AND PERFUMERY INDUSTRY

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Introduction

The introduction of Mentha arvensis, M. piperata, M. spicata and M. citrata in India for cultivation and production of essential oils has made a major breakthrough in the essential oil industry during the last two decades. Products like menthol and peppermint oil (BP) used to be imported into India till recently from Japan, Brazil, Formosa, U.K. etc., for medicinal and other purposes. The plants mentioned above have been introduced and established for large-scale cultivation under different agro-climates of India and they have yielded the essential oils with requisite constituents comparable to the standard of I.P. or other pharmacopea. Their development has not only cut down the imports but also provided work and employment to many and have generated working capital and assets of several crores of rupees. Attempts have been made even to produce these oils for export.

Mentha arvensis L. sub. sp. haplocalyx Briquet var. piperascens Holmes.

In early 1953, a Japanese Professor of Botany met the author at a scientific meet who requested for some seeds and plants of *Ephedra gerardiana* Wall. for his research work. These were collected and sent from Kashmir. The Professor felt very grateful and as a courteous gesture insisted to offer something in exchange; the author took the opportunity of asking for some live suckers of *Mentha arvensis* L. sub. sp. *haplocalyx* Briquet var. *piperascens* Holmes only.

For quite some time nothing was heard from the Japanese Professor and the author lost hope of getting anything from Japan. In December 1953, however, a Christmas gift arrived as pleasant surprise. It consisted of five fresh and translucent mentha suckers each about 5 cm (2 inches) long, neatly packed in a rolled

corrugated sheet wrapped in a polythene bag. A typed slip "Mentha arvensis L. Sub. sp. haplocalyx Briquet var. piperascens Holmes" was enclosed as a mark of identification, without the name of the sender. It was indeed a moment of great excitement and latent jubilation to receive this invaluable gift from the friend in Japan.

As this gift packet did not route through quarantine, steps were taken to sterilize the suckers against fungal or insect infection. They were then carefully planted in pots and were given undivided attention to keep them alive. After about forty days they sprouted and the first leaves appeared. The pots were then removed from laboratory to the nursery and in an endeavour to make the suckers somehow survive, each was put in a different environmental condition, viz., one in total shade; one in partial shade, one in full sunshine; and one or two transplanted to nursery beds. Fortunately, all the suckers survived and sprouted.

The leaves were later collected and distilled for oil. The percentage of oil and menthol was found to be as good as compared to its original habitat in Japan.

The daughter suckers were later grown and distributed for propagation at different places at Jammu and Kashmir State on a trial basis. After satisfactory growth and yield performance of these, they were released. They were distributed to progressive farmers and various agricultural institutions in India for experimental cultivation. Except for the Drug Research Laboratory which projected its cultivation on a 300 acre farm at Chakrohi (Jammu), little interest was shown by agricultural and other research institutions or progressive farmers until it was exhibited in the World Agriculture Fair held at New Delhi in 1959. Since then many people got interested in its cultivation on semi-commercial scale.

The Council of Scientific and Industrial Research set up Central Indian Medicinal Plants Organisation in 1958 for the commercial production of vegetable drugs and this organisation took up the cultivation of Mentha arvensis as one of its major projects for production of mint oil and menthol. The Drug Research Laboratory was also taken over by the CSIR for expansion and development of medicinal and aromatic plants. Central Indian Medicinal Plants Organisation (CSIR) later developed the cultivation and production of mentha oil and menthol at Jammu and Haldwani (U. P.). Subsequently, Richardson Hindustan Aromatics Ltd., installed a factory for production of mint oil at Bilaspur (U. P.); M/s Bhavana Chemicals Ltd., also set up their units on cottage scale basis in Tarai area of U. P. and quite a few other farmers took to cultivation of mentha. When the farmers were assured of good returns

from Mentha, its cultivation spread in the Tarai area, the soil of which suited for its successful growth.

As a result the import of mint oil and menthol which was about 200 tonnes valued at rupees one crore ($ 1.33 million) in early fifties dwindled down to 51.4 tonnes annually in 1965-66.

To date there are more than 300 farmers in India who grow mentha on about 4,000 heactares of land at different places in India; the major concentration is of course localised in Tarai region of U.P. In 1972, the total production of mint oil in India was over 200 tonnes which is sufficient to meet the internal demand.

It is interesting to record that not a single rooted sucker of Mentha arvensis was ever imported since the introduction of original five suckers which were procured by the author through a Japanese friend in 1953 and which were progressively multiplied and distributed for commercial cultivation.

Mentha piperita L.

With a view to produce the peppermint oil indigenously, attempts were made to introduce the genuine species of Mentha piperita L. since 1881 and plants were raised in Nilgiris, Mysore and Dehra Dun; but the oil obtained from either of these places was not up to official standards.

Peppermint oil of commerce is distilled from two varieties of mint viz., Mentha piperita var. vulgaris Sole (Black mint) and Mentha piperita var. officinalis Sole (White mint). Black mint, also known as English mint or Mitcham mint, is grown extensively in the United Kingdom, and United States of America because of its hardiness and higher yield of oil.

Suckers of both of Black and White mints were procured by the author from Royal Botanic Gardens, Kew, England, for introduction in Jammu and Kashmir. They set out new vegetative shoots and suckers in their new habitat but the growth was stunted in the sub-tropical climate at Jammu (274 m above sea level) whereas the plants put up fairly good vegetative growth in temperate climate at Srinagar (1524 m).

Both the varieties of *Mentha piperita* are polyploids and sterile and propagate vegetatively. The chromosome numbers are 2n = 76 and 2n = 36 for Black and White mints respectively.

Black mint has better vegetative growth and appears to be immune to rust attack; the White mint seems to be sensitive to rust and its vegetative growth is also not as vigorous as that of the Black mint.

The flowering shoots from both the varieties collected in autumn 1959 from Srinagar nursery yielded 0.50 and 0.70 per cent of peppermint oil v/w basis for black and white mint respectively. The plants from Jammu nursery were too small to give any estimable oil.

The plant has been now successfully grown in Jammu and Srinagar by Central Indian Medicinal Plants Organisation and Regional Research Laboratory, Jammu.

The area under this crop has been progressively increased at Haldwani.

The CIMPO has been instrumental to persuade the private farmers in Terai area to cultivate this crop and they could produce for the first time about 300 kg. of Mentha piperita oil.

Mentha citrata Ehrh.

Mentha citrata Ehrh. has been found to be a rich source for production of Linalool and Linalyle acetate from its oil which hold commanding position in perfume, cosmetic, soap and flavour industries. The existing source of these aroma chemicals is from the berries of Bursera delpechiana and leaves of Skimmia laureola Sieb and Zucc ex Walp. but there are limitations to their supplies.

Indian requires about 25-30 tonnes of oil per annum to obtain the required quantity of these aroma chemicals.

Mentha citrata which is an annual crop can on average yield oil about 100 kg./hectare annually by three harvests.

RRL Jammu has reported that 5 clones of M. citrata were grown in J & K. The original clone (first introduction) stands the best so far.

The total area under this crop between CIMPO and RRL at Jammu and Srinagar is about 6.00 acres. This area serves for the production of propagating material and experimental research.

Very little research work has been done so far excepting for improving the agro-technique to make it a successful introduction in Terai and Lucknow.

The oil percentage from the fresh herb at Lucknow from three harvests gave about 0.64 per cent. The oil yield was about 100 kg./hectare.

The plant was introduced in Kashmir also where the yield of oil was 1.3% containing 70% of Linalool/Linalyle acetate.

Trials conducted at Haldwani (India) by CIMPO during 1969-72 have revealed that crop planted during January in rows 60 cm. apart by using runners, stolons and seedlings with judicious application of nitrogen fertilizers (100-120 kg. N/ha.) in split doses preferably through foliar spray during vegetative growth of the crop gives an average yield of 28.30 tons herbage and 90.35 kg. oil/ha. in two harvests till August i.e. during 7 to 8 months period. However, maximum yield of herb and oil per hectare, i.e., 35.01 tons and 128.29 kg. oil respectively, were obtained from three harvests. The oil so produced has up to 41.6 per cent linalyl acetate and up to 86.7 per cent total alcohols as linalool, having pleasing lavender like odour and is acceptable to the industry. The oil can be a good source for isolation of natural linalool and linalyl acetate.

Mentha spicata Linn.

Mentha spicata (Spear mint) is cultivated in U.S.A. and Great Britain for the oil which contains 60-65% of carvone. The plant was first introduced in J & K but it remained in the nursery stage and no expansion was done.

CIMPO have planted and extended this plant at Haldwani farm, since 1971-72. The average yield of oil was 50 kg./hectare oil. The market pirce of the oil is fairly good but the farmers have not been too keen to extend the crop. There is need for more concentrated efforts to develop some hardy and improved cultivars.

The present production of oil from these plants is given as under:-

	Total production of oil	Average yield/ hectare	Present price per kg.
Mentha arvensis	200 tons	100 kg.	Rs. .80.00
Mentha piperita	5 tons	50 kg.	Rs. 200.00
Mentha spicata	N.K.	50 kg.	Rs. 300.00
Mentha citrata	N.K.	100 kg.	Rs. 90.00

The improved agronomic and distillation techniques can bring more profits to the growers of these plants which can prove contagious to other farmers to boost up the cultivation for better economic returns.

COMMERCIAL CULTIVATION OF FLOWERS

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The flowers are symbols of beauty, affection and peace. They are soul of the garden and carry the message of nature to man. In our country, flowers are well known for their sanctity and are offered for God worship in temples. The flowers are normally used on all festive occasions, in religious ceremonies and marriages and in all social functions the flowers and garlands are essentially used. In South and Central India, the ladies adorn their hair with flower beads or garlands.

Flower gardens have been popular in India since the time immemorial. A mention has been made of 'Ashokvana' in Ramayan, where Sita was living as a captive. *Saraca indica* was predominant in this garden. In Valmiki Ramayan different kinds of flowers, creepers and trees have been described. Kalidas in his play 'Shakuntala' and 'Asvaghosa' (100 A. D.) in his "Budha Charita" described lotus and flowers vividly. A description of the layout of parks, gardens and artificial lakes in the city of Indraprastha is given in 'Sabha Parva of Mahabharat'. The story of Lord Krishna's Kadamba tree *(Anthecephalus indicus)* is known to all. There is a mention of books of horticulture in literature. About 700 years ago the art of gardening was described by 'Sarangdhara' in his book 'Upvana Vinod' and "Sarangdhara paddhati". 1700 years ago 'Vatisyayana' described four kinds of gardens viz. 'Pramadodyan', 'Udyan', 'Vrikshavatika' and 'Nandanavan'. The fruits and ornamental flowers have been elegantly exhibited on the wall sculptures in Ajanta, Ellora, Elephanta and 'Khajuraho' frescoes.

Besides their aesthetic value, the flowers are important for their economic uses such as for cut blooms, and for extraction of scents and other products. Flowers are used in the manufacture of oil, perfumes and extracts. The perfume industry flourished at its peak in Moghal times. The flowers of Chaiti rose and Jasmine (Chameli) are in use for several decades for the

preparation of oil and perfumes and earn foreign exchange worth 1 crores rupees. A recent survey made by the I.C.A.R. has revealed that about 10,500 tonnes of cut flowers worth Rs 9.26 crores are sold annually in the markets of Bombay, Calcutta, Madras, Bangalore, Delhi and Varanasi. According to an estimate about 3,000 hectares are grown commercially under marigold, jasmine, rose, crossandra, lily and small flowered chrysanthemums. The seed and nursery business is also flourishing, as it is a source of income to many as a commercial proposition. The name of Sutton & Sons and P. P. Pocha are well known in flower seed industry.

Several flowers particularly the herbaceous annuals, biennials, perennials and bulbous flowers grown in gardens in our country have been introduced from Europe, America, Africa, China, Japan and other countries. Most of the exotic flowers were introduced and acclimatized during the Mughal and British periods. Still then the indigenous flowers wealth has its own significance. In Uttar Pradesh marigold, jasmine, roses etc. are very popular and important from commercial point of view. I would like to give some information about the cultivation aspect and income accruing from some of the indigenous flowers.

Marigold: Because of their ease in cultivation, wide adaptability to varying soil and climatic conditions, long duration of flowering attractively coloured flowers of excellent keeping quality, the marigolds are commercially cultivated for cut flowers specially for garlands in urban and rural areas mostly in the vicinity of temples. There are two common types of marigold, the African *(Tagetes erecta)* and the French *(T. patula)*. The former is a native of Mexico, while the latter mostly dwarf, a native of Mexico and South America. The African marigolds are generally tall (90 cm.) with large sized double flobular flowers of lemon, yellow, golden yellow, primrose, orange and bright yellow colours. The French marigolds are mostly dwarf, early flowering and compact with dainty single or double blooms, borne freely and covering (15-45 cm.) the entire plant. The colour of flowers may be yellow, orange, golden yellow, primrose, mahogany, rusty red, tangerine and deep scarlet.

The French marigold grows best in a light soil, while the African marigold requires a rich, well-manured and moist soil. A well-drained soil and sunny situation are essential for both types of marigolds. They are susceptible to frost. Seeds are sown in May-June in nursery beds or in seed pans or boxes. The sowing can also be done in August-October and February-March. The seedlings should be pricked when 2.5-5.1 cm. tall. After about one month, the seedlings should be transplated into beds or 25 cm. pots. The plants can be planted by stem cuttings in rains

and winter. Well-rotten cowdung manure should be applied to the plots. French marigolds need less manuring than African marigold.

One hectare of marigold gives income of Rs. 5000 to Rs. 6000 per annum.

Jasmines: Several species of Jasminum - climbing, trailing or shrub with erect habit namely Chameli, Juhi, Bela, Champa, Mogra, etc. are cultivated in U. P. The Jasmines, highly prized for fragrant flowers, are commercially grown for extraction of essential oil for perfume and for cut flowers for making garlands and 'Veni', the latter for hairs of ladies. The dwarf shrub like *Jasminum sambac* are planted 1-1.5 m. apart, while the creeper may be grown 3.5 m. apart trained on arbours, arches, pergolas, screen or walls. They are mostly propagated by layering and root suckers during the rainy season. Watering is withheld in November to bring the plant to rest. The shoots are also pruned to half their length in January and cowdung manure at the rate of 10 kg. per bush is applied after exposing the roots for few days. The flowering in *J. sambac* is best during summer particularly in June-July. The creepers bloom for a longer period. They yield 1000 to 2000 kg. per hectare, approximately worth Rs. 2000 to Rs. 2500.

Roses: There are two types of scented roses, the Damask, a Persian rose and Edward rose *(Rosa bourboniana)*, which are widely grown in gardens around Delhi, Agra, Lucknow, Ghazipur and Kanauj for preparing rose water, gulkand and perfume 'attar'. There are several distilling firms in Kanauj engaged in making these products on commercial scale. The Damask rose was introduced in India from Persia by Babar in 1526 A. D.; while the latter was introduced in 1840. There are six types of roses grown in gardens, namely, hybrid tea, floribunda, polyantha, climbing and rambling, miniature and shrub roses. The roses can be propagated by budding and cutting. The most suitable time for budding being from 15th November to 10th February. The Damask and Edward roses give a net income of Rs. 2000 to Rs. 2500 per hectare, while one acre rose nursery gives an income of Rs. 20 to 25 thousand per annum.

The attention of people engaged in ornamental gardening has been lately drawn towards the export of flowers to foreign countries for earning foreign exchange. The State Trading Corporation has exported cut flowers of roses, gladioli, freezia and narcissus to European countries, accruing good income to growers. The future of cultivation of flowers on commercial lines near big cities and towns suburbs is very bright, as free technical advice is readily available from Horticulture staff posted in Government gardens, districts, divisional headquarters and Horticultural Research Station.

CULTIVATION OF CYMBOPOGON SPP. IN BURDWAN DISTRICT, WEST BENGAL AND ITS PROSPECTS

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Introduction

India has vast resources of essential oil yielding plants but only a few of them have been systematically exploited in certain regions of India. The different species of Cymbopogon (Graminae) are important aromatic plants which yield essential oils of great commercial importance. The oil of C. flexuosus Stapf., commonly known as Lemon grass oil, is used for manufacture of vitamin-A and for medicines for heart diseases and is also employed as insect repellent and perfuming agent. The oil of C. martini Stapf. var. motia is rich in geraniol content and is also extensively used in the soap factory as well as in the cosmetic factory.

Some authentic compilations in this area of study are available (Chopra et al, 1956; Dimri et al, 1969; Gupta, et al, 1970; Kotnis and Rao, 1935; Lat et al, 1972 etc.). In West Bengal, it has been feasible to grow some aromatic plants in the altitudinal regions between 1200 to 1500 m of Eastern Himalaya by Chatterjee (1960). Recently Ghosh and Chatterjee (1973, 1975) tried to introduce some economically important essential oil yielding plants in the district of Burdwan, West Bengal.

In recent attempts to cultivate these plants in the district of Burdwan, West Bengal, experiments were performed to investigate into the possibilities of commercial cultivation of two species of Cymbopogon viz. C. flexuosus Stapf. and C. martini Stapf. var. motia in the following directions:

1) To ascertain optimum time of sowing and of transplanting for maximum yield.

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2) To ascertain the effect of different levels of N.P.K. on the yield of herbage and of oil.

3) To ascertain the effects of photoperiods on the yield of herbage and of oil.

Materials and Methods

Seeds of C. flexuosus Stapf. and C. martini Stapf. var. motia (Fam. Graminae) were obtained from Lemon grass Research Station, Odakkali, Kerala. All the experiments were laid out in a randomized block-design with three replications. Plot sizes were 0.001 hectare and rich in organically loamy soil having the following compositional characteristics: pH-6.00, N_2-0.4%, P(as P_2O_5)-0.03%,

pH-6.00, N_2-0.4%, P(as P_2O_5)-0.03%, Ca(as CaO)-0.01% and K-0.04%.

Following experiments were performed:

1) Optimum time of sowing and of transplanting: In both the species, the seeds were sown in nursery beds during the successive months of May, June and July, 1973. In the transplanting experiment, the seedlings of each sowing were transplanted at the age of 30 and 60 days to experimental plots.

2) Nitrogen (N), Phosphorus (P) and Potassium (K) effects: To find out the optimum dose of N:P:K for yield, a trial was conducted with two combinations as follows:

a) $N_1P_1K_1$ = 60:50:35 Kgs. per hectare

b) $N_2P_2K_2$ = 120:100:70 Kgs. per hectare

Entire amounts of P and K were applied at the time of planting.

3) Photoperiodic experiments: Two photoperiodic treatments (Long-day and Short-day) with varying photoinductive cycles (PIC) were performed as follows:

a) Long-days (16 L + 8 D) - 10, 20 and 30 PIC's.

b) Short-days (8 L + 16 D) - 10, 20 and 30 PIC's.

Two harvests (September and December) during first year and four harvests (April, July, October and December) from second year onwards were obtained from C. flexuosus Stapf., while C. martini Stapf. var. motia yielded one harvest (October)

in the first year and two harvests (May and October) from the second year onwards. The essential oil contents were f Von-Rechenberg modified by Guenther (1949). Essential oil contents were also analysed during different developmental stages of plants to determine the period of maximum oil formation.

Results and Discussion

The results of maximum yield of green herbage and essential oil contents per hectare of the two species obtained by optimum treatments of time of sowing and transplanting, N:P:K doses and photoperiodic experiments have been shown in the tables, 1, 2 and 3.

The study has indicated that transplanted plants produced higher yield of essential oil as compared to directly sown plants in both the species. The optimum periods for sowing and transplanting were June and July respectively for C. flexuosus and May and July for C. martini for higher yield.

N:P:K experiments produced higher yield of green herbage and essential oil per hectare in both the species. In C. flexuosus and C. martini, maximum herbage yield (732 q per ha. per year and 368 q per ha. per year respectively from second year onwards) and essential oil content (351.60 Kgs. per ha. per year and 194.40 Kgs. per ha. per year respectively from second year onwards) were recorded in $N_{60}P_{50}K_{35}$ Kgs. per ha. as compared to other treatments.

The experiment with photoperiods had shown that Long-day treatments embracing 20 PIC as most conducive to increase the herbage yield and oil yield per hectare as compared to short-day treatments which had produced inhibitory effects.

Essential oil formation increased with the age of the plants and maximum oil formation was noticed during reproductive stage of development, which declined later (Table 4).

So far as the qualities of the essential oils are concerned, the citral content of C. flexuosus and geraniol content (calculated as total alcohol) of C. martini var. motia came up to ISI specifications. It was also observed that maximum citral percentage (82%) in C. flexuosus and geraniol percentage (90%) in C. martini var. motia were obtained by the application of N:P:K ($N_{60}P_{50}K_{35}$ Kgs. per ha.) fertilizers.

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References

1. Chopra, R.N., Nayer, S.L. and Chopra I.C. Glossary of Indian Medicinal Plants, Vol.I. CSIR, New Delhi, 1956.

2. Chatterjee, S.K. A note on the Vegetatives propagation of essential oil yielding plants newly introduced at Mungpoo, Darjeeling, Sci. & Cult. 25, 687-688, 1960.

3. Central Indian Medicinal Plants Organisation, Lucknow, CSIR, 1965-73.

4. Dimri, B.P. & Khan, M.N.A. Commercial cultivation of Aromatic Plants in South India, Ind. Perfumer, Vol.XIII, Part-1, 1969.

5. Gupta, R., Vital drugs and essential oil bearing plants as future cash crops in India, Ind. Fmg., 12:6, 67-75, 1972.

6. Gulati, B.C., R. Gupta and S.P.S. Duhan. Trial cultivation of C. martini var. motia in Tarai and Bhabar tract of U.P. Ind. Oil Soap J. 36(4): 105-14, 1970.

7. Ghosh, M.L., Nandi, R.P. and Chatterjee, S.K., Proc. med. & Aro. Plants, ICAR, New Delhi, 116, 1973.

8. Ghosh, M.L. & Chatterjee, S.K. Effect of different levels of N:P:K on growth, development and essential oil content in two species of Cymbopogon (Graminae) in the district of Burdwan, West Bengal. Proc. of the 62nd Session of Ind.Sc. Cong., Part III, pp.111, 1975.

9. Guenther, E. The Essential oils, Van-Nostrand Co. Inc. New York, Vol.I, 1949.

10. Guenther, E. The Essential oils, Van-Nostrand Co. Inc. New York, Vol.IV. 1949.

11. Kotnis, M.S. & Sanjiva Rao, B. Studies in Indian essential oils, J. of the Ind. Inst. of Sc. Vol.18A, Part-XVII, pp.129-133, 1935.

12. Lal, R.N., M.C. Nigam & S.C. Dutta. Palmarosa oil - A potential source of perfumery grade geraniol in India. Perfumes and flavour association of India, Dec., 1972.

Table 1

Yield of green herbage in Cymbopogon flexuosus Stapf. under varying treatments

Treatments (Optimum)	Yield of green herbage (Q./ha.)							
	First year		Total	Second year				Total
	1st harvest (Sept.)	2nd harvest (Dec.)		1st harvest (April)	2nd harvest (July)	3rd harvest (Oct.)	4th harvest (Dec.)	
*Directly sown plants	60.00	50.00	110.00	100.00	120.00	130.00	100.00	450.00
**Transplanted plants	90.00	80.00	170.00	140.00	160.00	180.00	120.00	600.00
N : P : K (60 : 50 : 35 Kgs./ha.)	140.00	120.00	260.00	160.00	200.00	220.00	152.00	732.00
Photoperiod (16L + 8D) 20 PIC	120.00	88.00	208.00	x	x	x	x	x

* Sown on 20.6.1973
** Transplanted on 20.7.1973

Table 2

Yield of essential oil in Cymbopogon flexuosus Stapf. under varying treatments

Treatments (Optimum)	Yield of essential oil (Kgs./ha.)							
	First year		Total	Second year				Total
	1st harvest (Sept.)	2nd harvest (Dec.)		1st harvest (April)	2nd harvest (July)	3rd harvest (Oct.)	4th harvest (Dec.)	
* Directly sown plants	19.20	20.00	39.20	32.00	44.00	54.00	60.00	190.00
**Transplanted plants	28.00	32.00	60.00	56.00	64.00	80.00	54.00	254.00
N : P : K (60 : 50 : 35 Kgs./ha.)	62.80	60.00	122.00	70.40	88.00	114.40	78.80	351.60
Photoperiod (16L + 8D) 20 PIC	48.00	35.20	83.20	x	x	x	x	x

*Sown on 20.6.1973
**Transplanted on 20.7.1973

Table 3
Yield of green herbage and essential oil in Cymbopogon martini Stapf. var. motia under varying treatments

Treatments (Optimum)	Yield of green herbage (Q. ha.)				Yield of essential oil (Kg. ha.)			
	1st year	2nd year			1st year	2nd year		
	1st harvest (Oct.)	1st harvest (May)	2nd harvest (Oct.)	Total	1st harvest (Oct.)	1st harvest (May)	2nd harvest (Dec.)	Total
*Directly sown plants	68.00	112.00	148.00	260.00	21.60	51.20	69.60	120.80
**Transplanted plants	84.00	140.00	160.00	300.00	34.40	62.80	80.00	142.80
N : P : K (60 : 50 : 35 Kg./ha.)	134.00	160.00	208.00	368.00	66.80	80.00	114.40	194.40
Photoperiod (16L + 8D) 20 PIC	114.00	x	x	x	55.20	x	x	x

* Sown on 20.5.1973
** Transplanted on 20.7.1973.

Table 4

Patterns of essential oil formation during different developmental stages of Cymbopogon flexuosus Stapf. and Cymbopogon martini Stapf. var motia

Species	Treatments	Percent essential oil formation during developmental stages		
		Vegetative	Reproductive	Post-reproductive
C. flexuosus Stapf.	* Control	0.28	0.40	0.32
	** N : P : K	0.32	0.46	0.37
C. martini Stapf. var. motia	Control	0.26	0.48	0.39
	N : P : K	0.30	0.55	0.45

* Control = Transplanted plants

** N:P:K = 60:50:35 Kgs./ha.

ESSENTIAL OIL BEARING PLANTS OF KUMAON REGION OF UTTAR PRADESH

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Essential oils are those oily plant products which are steam volatile and are the sources of odoriferous substances. Alternatively they may be described as perfume containing natural products. They are found in different parts of the plant.

Essential oils and related aromatic chemicals have various uses and applications in industries like pharmaceutical, cosmetics, flavouring and incense etc.

India with its wide range of physical and climatic variations from tropical to almost Alpine, possesses a great variety of indigenous flora yielding essential oils. It is not therefore, surprising that manufacture of essential oils and allied products was being carried out as a flourishing trade in India from ancient times.

The importance of essential oil industry for this country can be judged from the fact that the value of essential oils and related goods demand is expected to be more than Rs 100 crores per annum and that the essential oils and oil bearing seeds and species worth more than Rs 25 crores are exported per annum. Our country is faced with the acute shortage of foreign exchange and therefore, it is high time to explore ways and means to develop the essential oil industry so that the greater variety and quantity of essential oils may be exported and lesser amount may be imported by exploitation of our plant resources. Nearly 1300 plant species exist[1] in our country which are known to yield essential oils and aromatic chemicals. Kumaon has more than 200 such species.

Kumaon is the name given to that portion of western Himalayas which is situated between Nepal frontiers on the east and Bhagirathi or eastern branch of the Ganges river on the west. It covers approximately an area of 11500 sq.miles. It has a wide range of physical and climatic variations which has favoured the development of rich and varied indigenous flora yielding perfume

and essential oils. Besides the indigenous plants there are also a large number of exotic plants introduced by foreigners who settled here in the beginning and brought with them these plants for ornamental and economic purposes. Edapho climatic conditions of Nainital and surrounding hills suited them so well that they grew profusely, widely and wildly, on the soil of this part of the country. Some of these plants yield a good percentage of essential oil while others, though having less quantity of the oil in them are of high perfume value by virtue of very pleasant odour possessed by them. It is the view of the botanists that nearly all types of the plant can be grown in one part or the other part of the Kumaon region.

The list of the wildly growing plants yielding essential oils is as follows:

Clematis montana, C. gouriana, C. grata, C. buchananiana, Anemone obtusiloba, Michelia kispora, M. montana, Annona, squamosa, Cissampelos Pareira, Cardamine impatiens, Sisymbrium wallichii, S. sophia, Brassica nigra, B. juncea, B. campestris, Eruca sativa, Capsella bursa, Pastoris, Lepidium sativum, Thalpsi arvense, Raphanus sativus, Viola serpens, Hypericum perforatum, H. patulum, Geranium wallichianum, G. pratense, Boenning-hausenia albiflora, Zanthoxylum alatum, Z. acanthopodium, Z. budruna, Z. oxyphyllum, Toddalia aculeata, Skimmia laureola, Murraya exotica, M. koenigi, Clausena pentaphylla, Imonia crenulata, Citrus medica, C. aurantium, Aeglex marmelos, Boswellia serrata, Melia azadirachta, Cedrella toona, Ilex odorata, Rhus cotinus, R. wallichii, Pistacia integerrima, Mangifera indica, Trigonella foenumgreacum, Melilotus alba, Shuteria densiflora, Dalbergia sissoo, Acacia farnesiana, Albizzia odorata, Prunus armeniaca, P. puddum, Geum urbanum, Potentila anserina, Agrimonia eupatoria, Rosa indica, R. moschata, R. psidium guava, Eugenia jambolana, Buplerum falcata, Carum carvi, Chaerophyllum villosum, Seseli indicum, Oenanthe stolofinera, Ligusticum elatum, Angelica glauca, Heracleum candicans, Caucalis anthriscus, Adina cordifolia, Pavetta indica, Nardostachys jatamanshi, Valeriana wallichii, V. hardwickii, Morina longifolia, M. persica, Veronia anthelmintica, V. cinerea, Ageratum conyzoides, Eupatorim cannabinum, Cythocline lyrata, Aster molliusculus, Erigeron canedis, Blumera lacera, B. aromatica, Sphaerenthus indicus, Inula racemosa, Xanthium strumarium, Achaellia millefolium, Tanacetum artemisiodes, Artemisia parviflora, A. scoparia, A. maritama, A. vulgaris, A. vestita, A. biennis, A. sacrorum, Saxifragali gulata, Jurinea macrocephala,

Rhodendron arboreum, Jasminum humile, J. grandiflora, J. officinale, Nyctanthes arbortristis, Osmanthus fragrans, Nerium odorum, Trachelospermum gragrans, Sesamum indicum, Adhatoda vasica, Lantana indica, Lippia nodiflora, Vitex negundo, Ocimum sanctum, Coleus aromaticus, Anisochilus caranosus, Pogestomon parviflorus, P. plectraanthoides, Elsholtz iadensa, Prilla ocimoides, Mentha sylvestris, Origanum vulgare, Thymus serpyllum, Hyssopis officinalis, Micromeria biflora, Salvia glutinosa, S. moorcroftiana, S. lantana, Nepeta leucophylla, Ruderalis, Brunella vulgaris, Anisomeles ovata, Leomurus cardica, Leucas cepahalotes, Ajuga bracteosa, Chenopodium album, C. botrys, Plygonum aviculare, Rumex nepalensis, Piper longum, P. nepalense, Cinnamomum tamala, C. gladuliferum, Machilus odoratissima, M. gamblei, Litsea sebifera, Loranthus odoratus, Putranjiva roxburghii, Cannabis sativa, Morus indica, Juglans regia, Betula alnoides, B. utilis, Salix tetrasperma, Cupressus torulosa, Juniperus communis, J. macropoda, Pinus excelsa, P. longifolia, P. gerardiana, Cedrus deodara, Picea morinda, Abies webbiana, A. pindrow, Curcuma zeodoria, C. longa, C. auranticacum, Zingiber officinale, Z. capitatum, Z. chysanthum, Costus speciosus, Iris germanica, I. nepalensis, I. komaonensis, Allium leptophyllum, A. odorum, A. schoenoprasum, Pyrus pashia, Rosa sericea, Pyrus lantana, P. microphylla, Contoneester nummularia, Cyperus rotundus, and other varieties, *Andropogon jwarancusa, A. schoenanthus* and *A. nardus.*

There are many wild growing plants in Kumaon hills, which have many interesting uses as flavouring, cosmetics, incense and medicinal and many of these are not known to the outside world. There is no doubt, if these plants are further explored then new incense, flavouring and medicinal plant products could be added to the modern civilization from the Kumaon hills. There are still many plants which have not yet been subjected to chemical investigations.

Below some worth-mentioning plants which are used in Kumaon region[2] by the people of the region for some purpose are given:

1. Acorous calamus Linn. (Araceae): The paste of the root in water is commonly used to kill the head lices. The root and rhizomes are commercially collected for calmus oil or used in Ayurvedic preparations such as "Sudarshan choorna", "Lavangadi choorna", "Chanderprabha vati" and "Saraswataishta" etc.

2. Viola serpens Wall. ex Roxb. and V. patrinii Ging (Violaceae): Large quantities of flowers are annually extracted and are commercially used in Unani recipes such as "Joshanda" and "Rogan bansafa". Dried flowers are used as purgative and in cough and cold by mixing with tea.

3. *Hedychium spicatum* Smith. var. acuminatum and H. ellipticum Ham. (Zingiberacea): Root powder mixed with water in the form of paste is applied on boils. Small parts of the root when kept in mouth cures bad throat.

4. *Selinium wallichianum* (DC) (Umbelliferae): The powder of root is used as incense in magico-religious rites known as "Jagar".

5. *Angelica glauca* Endgw (Umbelliferae): The powder of the root is administered with warm water in stomach troubles of children and checks vomitting. The roots are used for flavouring curry or dal as a seasoning agent. It is also believed that the seasoned dal or curry given to women after delivery restores strength and vitality.

6. *Cinnamum tamala* Ness and Eberm (Lauraceae): The leaves and bark mixed with tea cures cough and colds. Industrially leaves and barks are used as substitute for C. zeylanicum as "Tejpat" and "Dalchini" in the market. These are also used in many Ayurvedic recipes.

7. *Nardostachys jatamanshi* (Valerianaceae): Rhizomes are used as incense in magica-religious rites known as "Jagar" and to promote hair growth. Industrially rhizomes are used in Ayurvedic preparations and also in perfumery.

8. *Skimmia laureola* (Rutaceae): The dried leaves powder is ised as incense. It is also believed that musk deer eats its leaves and hence gets the musk.

9. *Mentha spicata* Linn. (Labiatae): Industrially it is used in Unani recipe known as 'Sata pudina'.

10. *Valeriana jatamanshi* DC. Jones syn. V. wallichi DC. (Valaerianaceae): The root powder mixed with sugar is used in urine troubles. Dried roots mixed with ghee are used as incense. The essential oil of roots of this plant is of export value.

11. *Pinus roxburghii or P. longifolia* (Pinaceae): Resin is used as healing plaster in swelling, sprains, boils and in bone fractures. Tons of resins are annually extracted from which terpentine oil, varnish and rosin of commerce are produced.

12. *Zanthoxylum alatum* (Rutaceae): The powder of seeds are used as tooth powder and applied on dental diseases and young twigs are used for cleaning teeth.

13. Boenninghausenia albiflora: The leaves are used as insecticides for killing the fleas.

The essential oil from some of the wildly occurring plants of Nainital has been extracted and studied in the chemical laboratories by the author and late Dr. K. K. Baslas and his co-workers.

The essential oil from the following plants raised in Kumaon region has been examined. The chemical examination of these oils has been already described in separate papers elsewhere.

Clematis buchnaniana, Artemisis vestita, Artemisia vulgaris, Nepeta leucophylla, Tagetes erecta, Salvia glutinosa, Cedrus deodar, Aster molliusculus, Boenninghausenia albiflora, Erigeron linifolius, Mentha sylvestris, Salvia leucantha, Tagetes patulis, T. minuta and several other plants.

The essential oil from several exotic plants raised in Kumaon has also been examined by the author. These plants are: *Anethum graveolens, Anethum sowa, Mentha arvensis, M. spicata, M. piperita, Eucalyptus citriodora, E. hybrid, Citronella* (Java), *Citronella* (Ceylon), Lemon grass, *Palmarosa, Artemisia pallense, Eucalyptus globulus, Cosmos bipinnatus, Limnophylla rugosa,* etc.

On comparing the properties of these oils extracted from the plants raised in Kumaon region and other parts of the country, it has been established that edapho-climatic conditions of Kumaon are suitable for the propagation of many commercially important exotics and if a wide scale cultivation of some of these important plants is carried out in this region, it will result in the large scale production of some essential oils which are imported in large amount and this will result in saving much foreign exchange. Mentha arvensis and M. piperita are good examples. These have been cultivated in this region on a large scale by farmers. Similarly Dill (oil from Anethum graveolense) can also be grown as a commercial crop like Mentha arvensis.

From preliminary cultivation trials in respect of different plants of Mentha genus it could be established by the author that the quantity of the oil is found to be increased at a little higher altitude.

From the preliminary work done so far it seems that Kumaon region may be developed as a good centre for the production of essential oils if properly exploited and this will help a lot in the economy of the country by way of earning and saving lot of foreign exchange which is the need of the hour for the country today.

The slow development and large scale farming of aromatic crop is due to the various reasons. A few of them may be:

1. The industry in our country is largely unorganized. Technical persons having good knowledge are not available to the industries. The facilities in the industries for research development and developing newer methods of production and analysis etc. are not of good standard.

2. Universities and Institutes in the country do not impart courses in cultivation of these aromatic plants and their analysis. This has created a vacuum of trained personnel in organizing and managing the commercial plantations which are necessary for rapid development of plantations and the industry.

The technique and equipment employed in the country is generally crude and to an extent primitive. Use of more sophisticated equipment, new developing techniques and formulation at all levels of production could effect much economy, both in time and material thus bringing down the production cost. The set-up of perfumery industry in the country needs reorientation. I mean the introduction of the most up-to-date equipment and universal adoption of the scientific knowledge in production of essential oils and aromatic chemicals in the essential oil industries which will play a major part in reviving and developing this industry.

A close coordination between research institute and the industry may make improvements in evolving new and newer techniques and equipment for industry with the increasing experience in this field.

CULTIVATION OF MENTHA PIPERITA

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Soil

Fertile and a well drained soil with little rain during the harvesting period are considered ideal. Light loose soils which dry quickly and heavy clay soils are not suitable for the cultivation of Mentha piperita. Water logged areas are not suitable at all for its cultivation. Under such conditions crop growth is affected adversely. The leaves turn yellow, become small in size and the plant ultimately develops less branches. Root rot can develop under these conditions. The crop can bear flowing water for one-two days.

Fertiliser

Mentha piperita responds quite favourably to liberal doses of both organic and inorganic manures. Best results are obtained when the field is green manured with leguminous crops like Dhaincha or Sanai and a further dose of farm yard manure is applied at the rate of 25 carts per acre. But if only inorganic manure is to be given, a basal dose of 50 kg. of diammonium phosphate is quite necessary. Basal dose of the fertiliser should be broadcast in the field before the last operation of harrow or the country plough as the case may be.

After the plants come up and are about 4 weeks old, it is always better to split the application of nitrogen in small periodical doses instead of applying it in a bulk. Usually 15 kg. of urea is is sufficient in each application after the field is irrigated.

For economy in fertilizer, foliar spray of two to three per cent urea can be applied in each top dressing and the number of applications can be increased.

Cultivation

Unlike Mentha arvensis, Mentha piperita does not develop succours for planting. One has to use the whole plant as planting material. Single branches of its plant are to be planted like sugar cane, at not more than one inch deep in the soil followed by a quick irrigation. The shorter the period between the sowing and the irrigation, the better will be the germination. The seed rate varies from two to three quintals of the planting material. The distance from row to row should not be less than 40 cm and not more than 60 cm. It is advisable to sow it on ridges as it is beneficial for the areas which are susceptible to water logging.

For better germination and good crop stand the planting material should be treated with some fungicide like Agallol or Tafason. As the plant is not dorment in the winter season, sowings can safely be done in the months of December and January.

Irrigations

This plant requires liberal irrigations. An assured irrigation is very necessary during the hot months of summer. Usually one irrigation every week is necessary during the hot months. There should be a foolproof arrangements for irrigation as its lack will make a marked difference in the green herb and ultimately the oil.

It has been observed that delay in irrigating the crop after the first harvest in the beginning of the month of May is very harmful to the crop. The field should immediately be irrigated for regeneration.

Interculture

As the crop needs liberal irrigations, weeds do come up and start competing with the crop. Timely weeding is a must in the initial stages of the crop growth as it helps in getting a good start for the crop. Usually three weeding are sufficient in the first cutting and two in the ratoon. Good results can only be expected if the field is kept weed free.

As the crop is sown in lines, during its early stages, hoeing with spade or interculture with a bullock drawn cultivator is practiceable, as these two methods are more economical than hand weeding. Hand weeding cannot be avoided once Mentha piperita fills in between rows.

Harvesting

Harvesting of this particular crop requires care as improper harvesting and handling can go a long way in the yield as well as the quality of the oil. Under no circumstances should it be stacked. Some time according to the season it may be allowed to wilt in the field itself and after that no time should be lost in transporting it to the distillation unit and its distillation. It is a 120 days crop and should be harvested after this time. Fields sown in the month of December and early January are ready for harvest in the last week of April and the first week of May.

Clear sunny days during few weeks immediately preceding the harvest, cause the herb to develop more oil than in the cloudy weather. Heavy rain at harvest time washes off considerable oil and also rough and careless handling when the herb has been permitted to become too dry causes loss of oil through the shattering of the leaves.

Yield of oil

12 to 15 Kg. of oil per acre in the usual yield out of the first cutting 8 to 10 Kgs. in the ratoon which matures in about 70 to 80 days after the first cutting.

ESSENTIAL OIL PLANTS OF KUMAON AND GARHWAL REGIONS OF UTTAR PRADESH

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Nainital-2

The Western Himalayan region resembles climatically and topographically very much with those of the European countries which are rich in aromatic flora. Therefore, the prominent portions of Western Himalayas are rich in aromatic flora.

Kumaon and Garhwal regions comprise that portion of Western Himalayas which is situated between Nepal frontier on the East and eastern bank of the Ganges river on the West. Its area amounts approximately to 11,500 square miles. The region can be divided into the following climatic zones:

Sl No.	Zones	Altitude	Localities
1.	Alpine	10-16,000'	Higher hills comprising Milam & Pindari glaciers
2.	Temperate	5,500-10,000'	Nainital, Almora, Uttar Kashi & Bageshwar
3.	Tropical	2-5,500'	Lower hills in Himalayas, Jeoli-kot, Ranikhet & Bhowali
4.	Sub-tropical	below 2,000'	Areas along the foothills of Himalayas & Terai bhabar

Climatic zones shown above have favoured the development of rich and varied aromatic flora in the Kumaon and Garhwal regions of Uttar Pradesh. According to work carried out by the Botanists the flora of Kumaon and Garhwal is a transition zone where many East Himalayan elements start their west-ward distribution. Affinities of the flora of Kumaon are much more stronger with the

Eastern Himalayan region that with that of Garhwal region, though many species start their distribution from Garhwal eastwards.

The author has tried to summarise the aromatic flora of these regions by describing the various genera and species belonging to different families. It has been found that 279 aromatic species belonging to 141 genera and 54 Natural Orders are distributed in Kumaon and Garhwal regions. Most of these species contain high percentage of essential oils and many of these could be of commercial value.

In the Table appended, the aromatic species belonging to different genera and the families are arranged alphabetically. Their distribution in these regions and Nainital in particular, with the colour of flowers, flowering season, specific localities and the altitudes between which these are distributed, have been tabulated.

References

Bhargava, K.S. and Gupta, R.K.: 'Seasonal material for a flora of Nainital'. Agra Univ. J.Res.(Sci.) 7(1), 1-48, 1958.
Collet, H.: 'Flora Simlensis' 1902.
Duthie, J.F.: 'Account of Botanical tour of Kumaon' 1886.
Guenther, E.: 'The Essential Oils' Vol.I-VI, 1957.
Hooker, F. and Thomson, T.: 'Flora Indica' 1885.
Jain, S.K.: 'Botanical trip to Nainital'. Ind.For. 82, 22, 38,1956.
Kanjilal: 'Forest flora of School Circle' 1901.
Osmaston, A.E.: 'A forest flora of Kumaon' 1927.
Strachey, R.: 'Catalogue of the plants of Kumaon, Garhwal & Tibet' 1918.

TABLE

Sl. No.	Name of N.O., Genera and species	Number of species distributed in		Colour of flower	Flowering season	Widely distributed at	Height
		Kumaon Garhwal	Nainital				
1	2	3	4	5	6	7	8
1.	ACANTHACEAE						
	Adhatoda	2	1				
	Adhatoda vasica Nees			p.pr.	Jan.-Apr.	Nainital upwards	5-6000
2.	ANACARDIACEAE						
	a) *Magnifera indica* L.	1	1	Li, Y	April	Bhabar & outer hills	1-3000
	b) *Pistacia integerrima* Stewart ex Brandis	1	-	R	May	Takula & Kosi river valley	2-5000
3.	ANNONACEAE						
	Anona	2	1				
	Anona squmosa L.			Gr. Y	April	Bhabar	1000
4.	APOCYNACEAE						
	a) *Nerium odorum* S.	1	1	Pk	May	Bageshwar	1-4000
	b) *Rauwolfia serpentina* Benth. ex Kurz.	1	1	W-Pk	May	Bhabar	1000

1	2	3	4	5	6	7	8
5.	ARISTOLOCHIACEAE						
	Aristolochia saccata Wall.	1	1	Pr-Bl	May	Nainital & Madhari	6-8000
6.	ARACEAE						
	Acorus calamus Linn.	1	1	-	Jun.-Jul.	Kapkot, Bhimtal, Outer hills	1-7500
7.	ASCLEPIADACEAE						
	Tylophora	3	-				
	i) *T. hirsuta* Wight			Gr-W	Jul.-Aug.	Almora	3-5000
	ii) *T. govanii* Dene			Pr	June	Jagthana Pass	8500
	iii) *T. tenerrima* Wight			Pr	Jul-Aug.	Kumaon	3-6000
8.	BURSERACEAE						
	Boswellia serrata Roxb.	1	1	W	May	Outer hills	1000
9.	CANNABINACEAE						
	Cannabis sativa Linn.	1	1	Gr	Sept.	Almora	2-5000
10.	CAPRIFOLIACEAE						
	Sambucus nigra Linn.	1	1	Y	-	Nainital	6500

1	2	3	4	5	6	7	8
11.	CHENOPODIACEAE						
	Chenopodium	6	1				
	i) C. botrys Linn.			Gr	May-Oct.	Almora, Nainital	5-6000
	ii) C. hybridium Linn.			Gr	May-Oct.	Garhwal	10000
12.	COMPOSITAE						
	a) *Achillea millefolium* L.	1	1	W-Pk	August	Kumaon	6-10000
	b) *Ageratum conyzoides* L.	1	1	Bl-W	May-Sept.	Outer ranges	1500
	c) *Anaphalis*	10	2				
	i) *A. contorta* (D. Don) Hk. f.			W	Sept.	Almora	5-9000
	ii) *A. nubigena* D. C.			W	August	Topid-hunge	14-15000
	d) *Articum lappa*	1	-	Pr	August	Garhwal	9-10000
	e) *Artemisia*	14	5				
	i) *A. biennis* Willd.	-	-	-	Sept.	Milam	11-15000
	ii) *A. laciniata* Willd.	-	-	-	-	Kumaon	8-12000
	iii) *A. macrocephala* J. ex Bess	-	-	Y	Sept.	Kumaon	14-15000
	iv) *A. maritima* L.	-	-	Y	Sept.	Jelam	9000
	v) *A. moorcroftiana* Wall. ex DC.	-	-	Pr	Aug.	Kali river valley	8-9000
	vi) *A. parviflora* Roxb.	-	-	Gr-Y	Sept.-Oct.	Kumaon	7-9000
	vii) *A. roxburghiana* B. Ex Wall.	-	-	Br	Aug.	Nainital, Binsar and Milam	7-11000
	viii) *A. sacrorum* L. Ledleb	-	-	Br	Aug.	Milam	11500

1	2	3	4	5	6	7	8
	ix) *A. salsoloides* Willd.	-	-	Gr-Y	Sept.	Guge	13500
	x) *A. scoparia* W. & K.	-	-	Gr-Y	Aug.	Hawal bagh & Milam	4-11000
	xi) *A. stracheyi* W.K.	-	-	Y	Sept.	Kumaon	12-15000
	xii) *A. stricta* Edgew	-	-	Gr-Y	Aug.	Milam	12-15000
	xiii) *A. vulgaris* Linn.	-	-	Gr-Y	Aug.	Nainital, Garampani	5-12000
	xiv) *A. vestita* Wall.					and Kedarnath	4-8000
f)	*Aster*	9	5				
	i) *A. asperulus* (DC.) H.K.F.	-	-	Pk	Aug.	Nainital, Ralam river, Gangoli	6-9000
	ii) *A. molliusculus* (DC.) Clarke	-	-	Li	Sept.	Nainital, Tisum & Rakshtal	6-15000
	iii) *A. thomsonii* Clarke	-	-	PK	Aug.	Nainital & Gangoli	6000
	iv) *A. pseudamellus* Hook.f.	-	-	Pr-W	Aug.	Darma, Kali river valley	8-13000
g)	*Blumea*	8					
	i) *B. aromatica*	-	-	Y,	March	Bhabar	1000
	ii) *B. glomerata*	-	-	Y	-	Kumaon	1-15000
	iii) *B. lacera* (Burm. F.) DC.	-	-	Y	-	Almora	4500
h)	*Cosmos bipinnatus* Cav.	1	1	W, PK, Pr.	Aug.-Sept.	Nainital	5-6000
	i) *Cythocline lyrata* C.	1	-	Pr.	Feb.	Almora	2-5000
j)	*Erigeron*	9	9				
	i) *E. canadensis* L.			R, Pr.	Sept.	Ranikhet	5-6000
	ii) *E. linifolius* Willd.	-	-	Gr, Y	Aug.	Nainital	6-7000
	iii) *E. multicaulis* Wall. ex DC.	-	-	W	Aug.	Nainital	5-7000
	iv) *E. multiradiatus* Bth.	-	-	Bl	Aug.	Nainital, Dudatoli	7-9000

1	2	3	4	5	6	7	8
k)	*Eupatorium*	2	-				
	i) *E. cannabinum* Linn.	-	-	Y	Oct.	Sarju valley	4000
	ii) *E. reevesii* Wall. ex DC.	-	-	W	Oct.	Kalimat, Binsar	6-7000
l)	*Inula*	6	4				
	i) *I. cuspidata* (DC) Clarke	-	-	-	Sept.-Nov.	Nainital, Lariakanta	6-8000
	ii) *I. rubricaulis* C.B. Clarke	-	-	Y	Feb.	Almora, Nainital	5-7000
m)	*Saussurea*	20	4				
	S. candicans Clarke	-	-	Pr,R	March	Nainital	6-8000
n)	*Sphaeranthus indicus* Linn.	1	-	Pr	April	Almora	5-5500
o)	*Tanacetum*	6	-				
	i) *T. longifolium* Wall. ex. DC.	-	-	Y	Sept.	Pindari & Tungnath	12000
	ii) *T. nubigenum* Wall.	-	-	Y,Or	Sept.	Pindari & Almora	5-12000
13.	CONIFERAE						
a)	*Abies*	2	1				
	i) *A. pindraw* Royle	-	-	-	May	Nainital, Kathi	7-10000
	ii) *A. webbiana* Lindl.	-	-	-	May	Champawat, Dwali	9-11000
b)	*Cedrus libani* Barrel var. *deodara* HK.	1	1	-	Sept.	Kumaon, Jelam	9-11000
c)	*Cupressus torulosa* D.Don.	1	1	-	Feb.	Nainital	4-9000
d)	*Junipers*	4	2				
	i) *J. communis* Linn.	-	-	-	May	Milam, Rimlim	9-11000
	ii) *J. macropoda* HK.F.	-	-	-	June	Milam, Malari	9-4000

1	2	3	4	5	6	7	8
	e) *Picea morinda* Link.	1	-	-	Sept.	Joshimath	5 -11000
	f) *Pinus*	4	3				
	i) *P. excelsa* Wall non Lamb.	-	-	-	May	Nainital, Joshimath	5 -11000
	ii) *P. gerardiana* Wall ex Lamb.	-	-	-	-	Malari, Bampa	6 -10000
	iii) *P. longifolia* Roxb.	-	-	-	Feb.	Nainital & Outer hills	2 -7500
	iv) *P.roxburghiana* Sarg.	-	-	-	March-	Nainital & Kumaon	2 -7500
	g) *Tsuga burnoniana* Corr.	1	-	-	-	Eastern Kumaon	8 -10000
14.	CONVOLVULACEAE						
	Convolvulus arvensis L.	1	1	Pk	Apr.-Oct.	Nainital, Kaladungi road	Up to 7500
15.	CRUCIFERAE						
	a) *Brassica*	3	-				
	i) *B. juncea* Coss.	-	-	Y	March	Almora	1 -6000
	ii) *B. nigra* Koch.	-	-	Y	March	Almora	1 -6000
	b) *Eruca sativa* Mills	1	-	W	May	Almora & Outer ranges	1 -6000
	c) *Nasturtium*	2	2				
	i) *N. montanum* Wall.	-	-	Y	March	Outer ranges	
	ii) *N. officinale* R. Br.	-	-	Br.	June	In several localities	1 -12000
	d) *Raphanus sativus* L.						

1	2	3	4	5	6	7	8
16.	CYPERACEAE						
	Cyperus	3	2				
	i) *C. iria* Linn.	-	-	-	Aug.	Nainital, Kumaon	Above 5000
	ii) *C. niveus* Retz.	-	-	-	June	Nainital, Kumaon	5-7000
	iii) *C. rotundus* L..	-	-	R, Br	-	Almora	4000
17.	DIPTEROCARPACEAE	1					
	a) *Dipterocarpus indicus* B.						
	b) *Shorea robusta* G.	1	1	Y	April	Outer hills	1-2000
18.	DIPSACEAE						
	Morina	3	2				
	M. longifolia Wall.	-	-	Pk	Aug.	Ralam, Pindari	11-12000
	M. persica L.	-	-	P, W	June	Nainital	8000
19.	ERICACEAE						
	Gaultheria	2	-				
	G. trichophylla Royal	-	-	Pk	June	Madari pass	10-12000
20.	EUPHORBIACEAE						
	Putranjiva roxburghii Wall.	1	-	Y	March-May	Bhabhar	1000

1	2	3	4	5	6	7	8
21.	GESNERIACEAE						
	Didymocarpus pedicellata R. Br.	1	1	Pr	August	Nainital, Ranibagh, Mohar garhi, Bageshwar	3-5500
22.	GERANIACEAE						
	Geranium	12	5				
	G. robertianum L.	-	-	Pr	Sep.	Pandukesar	6500
23.	GRAMINAE						
	a) *Andropogon*	28	2				
	i) *A. aciculatus*	-	-			Kumaon	1-4000
	ii) *A. distans* Nees ex Steud	-	-			Nainital, Kumaon	4-7000
	iii) *A. intermedius* R. Br.					Kumaon	1-3000
	iv) *A. jwaruncusa* Jones					Bhabar	1-4000
	v) *A. nardus* HK. F.					Outer hills	1-4000
	vi) *A. schoenanthus* HK. F.					Adhabadri, Garhwal	1-4500
	b) *Arundo donax* Linn.	1	-			Kapkot, Jalat	1-5000
24.	HYPERICACEAE						
	Hypericum	9	5				
	a) *H. cordifolium* (Chois)	-	-	Y	Aug.	Ramari	4-5000
	b) *H. japonicum* Thumb	-	-	Y	July	Almora	4-6000
	c) *H. perforatum* Linn.	-	-	Y	July	Nainital	6-7000

1	2	3	4	5	6	7	8
25.	IRIDACEAE						
	Iris	4	2				
	i) *I. decora* Wall.	-	-	Y,R	July	Nainital	5-7000
	ii) *I. germanica* Linn.	-	-	Bl	April	Almora	5500
	iii) *I. kumaonensis* Wall.	-	-	Bl	June	Nainital, Pindari, Niti	8-15000
26.	JUGLANDACEAE						
	Juglans regia Linn.	1	1	Gr.	March	Nainital, Dwali	4-8000
27.	JUNCACEAE						
	Juncus	12	1				
	Juncus glaucus Ehrh.			Br.	June	Binsar, Nainital	6-7500
28.	IABIATAE						
	a) *Ajuga*	5	3				
	i) *A. bracteosa* Wall. ex Benth.			Pk	March	Almora, Hawalbagh	4-8000
	ii) *A. parviflora* Benth.			Bl	May	Almora	5500
	b) *Anisomeles ovata* R. Br.	1	1	Bl	June	Nainital, Gori valley	1-6000
	c) *Brunella vulgaris* Linn.	1	1	Pr	Aug.	Nainital	6-10000
	d) *Calamintha*	2	1				
	i) *C. clinopodium* Benth.	-	-	Bl	Aug.	Ralam	12000
	ii) *C. Umbrosa* (M. Bieb) Fisch Mey	-	-	Bl	Aug.	Nainital, Almora	5-8000

1	2	3	4	5	6	7	8
e)	*Coleus barbatus* (Andr)	1	-	Bl	Sept.	Almora	4-5000
f)	*Elsholtzia*	10	3				
	i) *E. cristata* Willd.	-	-	Pr	Oct.	Jalat	6-7000
	ii) *E. densa* Benth.	-	-	Y	Aug.	Ralam	6-7000
	iii) *E. falva* Benth.	-	-	Y	Sept.-Oct.	Nainital, temperate region of Kumaon	5-7000
	iv) *E. fruticosa* (D. Don) Rehder	-	-	P, Y	Sept.-Oct.	Nainital	6-9000
g)	*Hyssopus officinalis* L.	1	-	Pr	Aug.	Malari	8-11000
h)	*Leucas*	4	3				
	i) *L. cephalotes* S.	-	-	W	May	Hawalbagh	1-4000
	ii) *L. hyssopifolia* Bth.	-	-	W	May	Bageshwar	3-4000
	iii) *L. lanata* Benth.	-	-	W	May	Almora	4-5000
	iv) *L. mollissima* Wall.	-	-	W	May	Almora, Nainital	5-6000
i)	*Melissa parviflora* Benth.	2	-	W	Aug.	Ramganga, Gori valley	5-6000
j)	*Mentha sylvestris* Linn.	1	1	Pk	Aug.	Temp. Kumaon, Nainital, Niti	4500-11000
k)	*Micromeria biflora* (Ham.) Benth.	1	1	Pk	Aug.	Malari	8-11000
l)	*Mosla ocymoides* (Ham. ex Bth.)	1	1	Pr, W	Aug.	Almora	4500
m)	*Nepeta*	13	6				
	i) *N. ciliaris* Bth.	-	-	Li	July-Oct.	Temp. Kumaon, Nainital	6-7000
	ii) *N. connata* Royle Ex. Bth.	-	-	Bl	July-Oct.	-do-	7-10000
	iii) *N. distans* Bth.	-	-	Pk	July-Oct.	-do-	7000
	iv) *N. elliptica* Royle ex Bth.	-	-	Li	Sept.	Nainital	6-7500

1	2	3	4	5	6	7	8
	v) *N. leucophylla* Benth.	-	-	Li	July-Oct.	Nainital	6-7500
	vi) *N. linearis* Royle Ex. Bth.	-	-	-	Aug.	Gini	7-8000
	vii) *N. ruderalis* Ham.	-	-	Pr	Feb.	Outer hills	1-5000
	viii) *N. spicata* Benth.	-	-	Pr	Feb.	Milam, Ralam	8-12000
	ix) *N. tibetica* Benth.	-	-	Bl.	Aug.	Kyungar, Langari	15-17000
n)	*Ocimum sanctum* Linn.	1	1	Pk	-	Kumaon	1-5000
o)	*Origanum*	2	1				
	i) *O. normale* D. Don.	-	-	Pk	Aug.	Almora	6000
	ii) *O. vulgare* Linn.	-	-	Pk	Aug.	Milam	6-11000
p)	*Perilla ocymoides* L.	1	1	W	Aug.	Bhabar, Dwali	1-8500
q)	*Plectranthus*	9	4				
	i) *P. gerardianus* Wall. ex. Benth.	-	-	W	Sept.-Oct.	Temp. Kumaon, Nainital	5-10000
	ii) *P. japonicus* K.	-	-	Bl	Sept.-Oct.	Nainital	7-8000
	iii) *P. rugosus* Wall. Ex. Bth.	-	-	W	July-Oct.	Temp. Kumaon, Nainital	5-8000
	iv) *P. striatus* Wall. ex. Bth.	-	-	W	Aug.-Oct.	-do-	5-8000
r)	*Salvia*	7	4				
	i) *S. campanulata* Wall.	-	-	Bl	June	Temp. regions	10-11000
	ii) *S. glutinosa* L.	-	-	Y	Aug.	Nainital, Niti, Dugli	7-11000
	iii) *S. lanata* Roxb.	-	-	Bl	March	Almora, Nainital	4-8000
	iv) *S. leucantha* Cav.	-	-	W	Aug.	Nainital	6-7500
	v) *S. moorcroftiana* Wall. ex Bth.	-	-	P, Bl	Aug.	Nainital, Temp. regions	6-9000
	vi) *S. plebeia* R. Br.	-	-	Bl	March	Outer hills	1-5000
s)	*Thymus serphyllum* Linn.	1	1	Pk	Aug.	Ralam, Raj hoti	10-14000

1	2	3	4	5	6	7	8
	t) *Teucrium*	3	2				
	i) *T. laxum* Don	-	-	Pk	Feb.	Ramganga valley	4-5000
	ii) *T. quadrifarium* Ham.	-	-	Li	Aug.	Nainital	5-8000
	iii) *T. royleanum* Wall. ex. Bth.	-	-	W	Aug.	Almora	5000
29.	LAURACEAE						
	a) *Cinnamomum*	2	1				
	i) *C. glanduliferum* M.	-	-	W	May-June	Pithoragarh	4-4500
	ii) *C. tamala* Nees & Eberm	-	-	W	May	Nainital, Bageshwar valley, Lohaghat	3-4500
	b) *Litsea*	5	4				
	i) *L. elongata* Wall. ex HK.	-	-	Y	Aug.	Nainital, Temp. Garhwal	6-7500
	ii) *L. lanuginosa* N.	-	-	W	June	Outer hills	2-6000
	iii) *L. umbrosa* Nees	-	-	Pr, Y	March-May	Nainital	6-7500
	c) *Machilus*	4	1				
	i) *M. gamblei* King ex HK.	-	-	P, Y	March-Apr.	Bhimtal-Bhowali	4-6000
30.	LEGUMINOSAE						
	a) *Acacia farnesiana* (Linn.) Willd.	1	-	Y	July	Almora	5500
	b) *Cajanus indicus* S.	1	-	Y	Oct.	Ganai	3000
	c) *Dalbergia*	4	-				
	D. sissoo Roxb.	-	-	Pk	Feb.	Bhanar	1-2000

1	2	3	4	5	6	7	8
31.	LICHENS						
	Usnea	3	-				
	i) *U. ceratina* Ach.					Chinar	8700
	ii) *U. himalayana* B.					Chinar	8700
	iii) *U. longissima* A.					Binsar	7000
32.	LILIACEAE						
	a) *Allium*	8	3				
	i) *A. auriculatum* K.			Pr	-	Kumaon	10000
	ii) *A. rubellum* M. Bieb.			R	May	Temp. Kumaon, Nainital	5-8000
	iii) *A. wallichii* K.			Pk	June	Temp. Kumaon, Ralam, Nainital, Chinar	8-12000
	iv) *A. stracheyi* B.			Pk	Aug.	Ralam, Pithoragarh	10-12000
	b) *Lilium*	6	3				
	i) *L. nepalensis* D. Don			Or, R	June	Nainital	8-9000
	ii) *L. polyphyllum* D. Don			Gr, Y	July	Pindari, Campawat, Temp. Kumaon	6500-12000
	iii) *L. Wallichianum* Schult.			Gr, W	Aug.	Temp. Kumaon	4-6000
33.	MAGNOLIACEAE						
	Michelia kisposa B.	1	-	W	May	Gagar	6-7000

1	2	3	4	5	6	7	8
34.	MALVACEAE						
	a) *Hibiscus*	6	1				
	i) *H. radiatus* Willd.			Y,Pr	Aug.	Almora	4000
	ii) *H. pugens* Roxb.			Y,Pr	Jul-Oct.	Nainital, Jeolikot	2500-5000
	b) *Urena*	1	-				
	U. lobata Linn.			Pk	Aug.	Outer hills, Bageshwar	1-3000
35.	MELIACEAE						
	a) *Cedrela*	2	1				
	i) *C. serrata* Royle			Pk	June	Bandani Devi, Nainital	4-7500
	ii) *C. tonna* Rexb.	-	-	W	March	Kota-dun	1-2500
	b) *Melia*	2	-				
	M. azedarach Linn.	-	-	Li	March-May	Outer hills	1-4000
36.	MENISPERMACEAE						
	Cissampelos pareira Linn.	1	1	Gr,Y	May	Bageshwar, Nainital	3-4500
37.	MYRTACEAE						
	a) *Eugenia*	2	-				
	i) *E. jambolana* Lam.	-	-	W	March	Bhabar	1-2000
	ii) *E. operculata* R.	-	-	Gr	Apr.-May	Bhabar	1-2000

1	2	3	4	5	6	7	8
	b) *Psidium*	1	-				
	P. guajava Linn.	-	-	Y, W	February	Outer hills	1-5500
38.	MYRICACEAE						
	Myrica	4	4				
	M. esculenta B. H.	-	-	W	Aug-Oct.	Nainital-Almora	4-7000
39.	OLEACEAE						
	a) *Jasminum*	7	5				
	i) *J. grandifolorum* L.	-	-	W	March	Almora	4-5000
	ii) *J. officinale* Linn.	-	-	W	May	Nainital, Kathi	7-8000
	b) *Nyctanthes*	1	1				
	N. arbortristis Linn.	-	-	Y	August	Kota-dun	2-3500
	c) *Olea*	2	2				
	i) *O. gladulifera* Wall.	-	-	W	April-May	Nainital-Kumaon	6-7500
	ii) *O. cuspidata* Wall.	-	-	W	June	Joshimath	6-8000
	d) *Syringa*	1	-				
	S. emodi Wall. ex G. Don.	-	-	W	May	Dwali, Niti	8-11500
40.	PIPERACEAE						
	a) *Piper*	3	2				
	i) *P. brachystachym* W.	-	-	Pr	June	Kumaon	2-5000
	ii) *P. longum* Linn.	-	-	-	-	Barbar	1-2500
	iii) *P. nepalense*	-	-	-	-	Garhwal	3-5000

1	2	3	4	5	6	7	8
	b) *Houttuynia*	1	1				
	H. cordata Thumb.			Gr	June	Garhwal, Jeolikot	1-5000
41.	POLYGONACEAE						
	a) *Polygonum*	54	18				
	i) *P. alatum* BH. ex D. Don	-	-	Pk	May	Nainital	6-11000
	ii) *P. chinense* Linn.	-	-	Pk	May	Nainital	6-7000
	iii) *P. flaccidum* M.	-	-	W	May	Bhimtal, Ranikhet	4-6500
	iv) *P. glabrum* Willd.	-	-	Pk	July	Nainital, Kosi river valley-Garhwal	1-6500
	v) *P. hydropiper* Linn.	-	-	W	July-Oct.	Bageshwar, Bhimtal, Nainital	3-4500
	vi) *P. plebejum* R. Br.	-	-	Pk	March	Outer hills	1-7000
	vii) *P. serrulatum* Lagg.	-	-	-	July-Oct.	Bhimtal, Nainital	4-7000
42.	RANUNCULACEAE						
	a) *Anemone*	6	2				
	i) *A. elongata* D. Don	-	-	W	June	Chekani Khal	10000
	ii) *A. rivularis* BH.	-	-	W, Pr	Aug.	Nainital	6500-11000
	iii) *A. vitifolia* BH.	-	-	W	July	Outer hills	5-7500
	b) *Clematis*	12	7				
	i) *C. acuminata* D. Don.	-	-	W	July	Nainital, Binsar	7-8000
	ii) *C. buchaniana* D. C.	-	-	P, Y	Aug.-Nov.	Nainital, Outer ranges	7-9000
	iii) *C. montana* B. H.	-	-	W	Apr.-May	Nainital, Tiffintop	5-7000

1	2	3	4	5	6	7	8
	ROSACEAE						
a)	*Agrimonia*	1	1				
	A. eupatoria Linn.	-	-	Y	June	Nainital	6-7500
b)	*Rosa*	7	2				
	i) *R. hookeriana* (Bertol)	-	-	R	July	Tola Chechani Khal	10-11000
	ii) *R. indica* L.	-	-	R	-	Outer ranges	1-5500
	iii) *R. involucrata* R.	-	-	W	March	Terai	1-5500
	iv) *R. macrophylla* Lindl.	-	-	R	June	Nainital, Binsar	6-9000
	v) *R. moschata* Mill.	-	-	W	April	Nainital, Binsar	2-8500
	vi) *R. sericea* Lindl.	-	-	W	June	Kathi, Milam, Niti	8-13000
	vii) *R. webbiana* Wall.	-	-	R	July	Niti	9-11500
c)	*Prunus*	8	2				
	i) *P. armeniaca* Linn.	-	-	Pk, W	March	Almora	1-5000
	ii) *P. padus* (Linn.) Hk.f.	-	-	W	April	Nainital, Dwali	6-11000
	iii) *P. puddum* Roxb. ex Brendis	-	-	Pk	Oct.-Dec.	Almora, Nainital	5-7000
d)	*Gexum*	2	1				
	i) *G. elatum* Wall.	-	-	Y	June	Patharkori	10-11500
	ii) *G. urbanum* Linn.	-	-	Y	June	Nainital, Namik	7-11000
e)	*Rubus*	19	7				
	i) *R. acuminatus* Sm.	-	-	W	-	Kumaon	4-7000
	ii) *R. foliosus* Don	-	-	Pk	April	Nainital, Binsar	7500
	iii) *R. paniculatus* Sm.	-	-	W	May	Nainital, Sarju valley	6500
	iv) *R. rosaefolius* Sm.	-	-	-	May	Nainital	7000

1	2	3	4	5	6	7	8
44.	RUBIACEAE						
	a) *Adina*	1	-				
	A. cordifolia Roxb.	-	-	W	-	Bhabar	1000
	b) *Gardenia*	2	1				
	i) *G. montana*	-	-	W	Mar.-Apr.	Kota-dun	2000
	ii) *G. turgida* Roxb.	-	-	W	Mar.-Apr.	Bhabar	1000
45.	RUTACEAE						
	a) *Aegle*	1	1				
	A. marmelos Correa	-	-	Gr, W	May	Bhabar	1-2000
	b) *Boenninghausenia albiflora* Reich.	1	1	W	July-Oct.	Nainital	4-7000
	c) *Citrus*	2	-				
	i) *C. aurantium* Linn.	-	-	W	May	Outer hills	1-3000
	ii) *C. medica* Linn.	-	-	W, Pr	-	Bageshwar	1-4000
	d) *Clausena*	1	-				
	C. pentaphylla D.C.			W	Apr.-May	Kota Dun	2000
	e) *Murraya*	2	1				
	i) *M. exotica* Linn.	-	-	-	March	Outer hills	2-5000
	ii) *M. koenigii* Spreng	-	-	-	March	Nainital, Bhabar	1-3000

1	2	3	4	5	6	7	8
f)	*Skimmia*	1	1				
	S. laureola Sieb.	-	-	Y	May/June	Nainital	7-9500
g)	*Toddalia*						
	T. aculeata Pers.	-	-	Gr, Y	Feb.	Bageshwar	3000
h)	*Zanthoxylum*	4	2				
	i) *Z. acanthopodium* WG. DC.	-	-	-	Sept.	Karim, Nainital	½-7000
	ii) *Z. alatum* Roxb.	-	-	Y	Apr.-Jun	Nainital, Jalat, Bhimtal	4-7000
	iii) *Z. oxyphyllum* Edgew.	-	-	Pk	May	Kathi, Dwali	7-8500
46.	SANTALACEAE						
	Osyris	1	1				
	O. wightiana Wall. Ex. Wight	-	-	Y, Gr	Through-out the yr.	Nainital, Kalimath	1-6000
47.	SAPOTACEAE						
	Bassia	2	1				
	i) *B. butyracea* Roxb.	-	-	P, Y	January	Bhabar	1000
	ii) *B. longifolia* L.	-	-	W, Y	January	Sarju valley	3000

1	2	3	4	5	6	7	8
48.	SCROPHULARIACEAE						
	Limnophila	3	-				
	i) *L. roxburghii* G. Don	-	-	Pr, Y	July	Almora	4000
	ii) *L. roxburghii* var. *intermedia*	-	-	Pr	Feb.	Pathidun	1500
49.	TERNSTROEMIACEAE						
	Saurauja	1	1				
	S. napaulensis DC.	-	-	Pk	Nov.	Outer hills	3-5000
50.	UMBELLIFERAE						
	a) *Angelica*	1	-				
	A. glauca E.	-	-	W	Aug.	Ralam valley	8-11000
	b) *Carum*						
	i) *C. anethifolium* B.			W	Aug.-Sept.	Nainital, Almora	5-6500
	ii) *C. carvi* Linn.	-	-	W	July-Aug.	Nainital, Tola	7-11000
	c) *Caucalis*	1	1				
	C. anthriscus Scop.	-	-	Pk	Aug.	Nainital, Paton	5-6500
	d) *Chaerophyllum*	1	1				
	C. acuminatum Lindl.	-	-	W	July-Aug.	Kumaon, Nainital	5-9000
	e) *Heracleum*	3	2				
	i) *H. brunonis* B.	-	-	W	Aug.	Ralam, Milam	13500
	ii) *H. candicans* Wall.	-	-	W	July-Aug.	Nainital	6-7500
	iii) *H. canescens* Lindl.	-	-	-	July-Aug.	Nainital	6-7500

1	2	3	4	5	6	7	8
	f) *Ligusticum*	1	1				
	L. marginatum C.B. Clarke	-	-	W	Aug.	Nainital	7000
	g) *Peucedanum*	1	-				
	P. dhana B.H.	-	-	Y	May	Almora, Outer hills	5-6000
	h) *Pimpinella*	6	3				
	P. acuminata C.B.Clarke	-	-	W	Aug.	Nainital	6-7000
	i) *Selinum*	4	2				
	i) *S. tenuifolium* Wall.	-	-	W	Aug.	Nainital	6-10000
	ii) *S. vaginatum* Clarke	-	-	W	July-Aug.	Kumaon, Nainital	6-10000
	j) *Seseli*	2	1				
	i) *S. indicum* Wall.	-	-	W	-	Outer ranges	10000
	ii) *S. trilobum* Benth.	-	-	W	Aug.	Niti, Milam, Garhwal, Nainital	7-10000
51.	VIOLACEAE						
	Viola	6	5				
	i) *V. biflora* Linn.	-	-	Y	May	Nainital	6-9000
	ii) *V. distans* Wall.	-	-	Li, Bl	-	Nainital	5-7000
	iii) *V. patrinii* Ging.	-	-	Bl	March	Outer hills, Nainital	4-5000
	iv) *V. serpens* Wall.	-	-	Bl	May	Nainital	4-8000
52.	VALERIANACEAE						
	a) *Nardostachys*	2	1				
	i) *N. forma grandiflora*	-	-	Pk	Aug.	Pindari	13000

1	2	3	4	5	6	7	8
	ii) *N. jatamansi* DC.	-	-	P, W	Aug.	Ralam, Milam, Nainital	8-12000
	b) *Valeriana*	5	2				
	i) *V. hardwickii* Wall.	-	-	Pk	Aug.	Nainital, Ralam valley	6-8000
	ii) *V. wallichii* DC.	-	-	W	March-May	Almora, Nainital	5-700
53.	VERBINACEAE						
	a) *Callicarpa*	2	2				
	C. macrophylla Vahl.	-	-	Li	Aug,	Outer hills, Bageshwar	1-4000
	b) *Lantana*	1	1				
	L. indica Roxb.	-	-	W	March	Nainital, Outer hills	1-3500
	c) *Lippia*	1	-				
	L. nodiflora Rich.	-	-	Pr, Br	March	Kalapathar, Outer hills, Nainital	2-4000
	d) *Vitex*	2	1				
	i) *V. negundo* L.	-	-	Pr	April	Nainital Bhabar	1-4000
	ii) *V. varincisa*	-	-	-		Bhimtal	4-5000
	e) *Verbena*	1	1				
	V. officinalis Linn.	-	-	Li	March	Outer hills	1-6000
54.	ZINGIBERACEAE						
	a) *Costus*	1	-				
	C. speciosus (Koen.) Sm.	-	-	Pr	Aug.	Sarju valley	2500

1	2	3	4	5	6	7	8
b)	*Curcuma*	3	2				
	i) *C. angustifolia* Roxb.	-	-	Or	May	Bageshwar	3-6000
	ii) *C. longa* Linn.	-	-	Y	-	Nainital, Outer hills	1-4000
	iii) *C. zedoaria* Rosc.	-	-	Y	-	-do-	1-4000
c)	*Hedychium*	6	2				
	i) *H. elatum* R. Br.	-	-	Or	Aug.	Jageshwar	4-5000
	ii) *H. ellipticum* B. H.	-	-	Y	Aug.	Bageshwar valley	3-4000
	iii) *H. spicatum* var. *accum inatum*	-	-	W/PK	Aug.	Nainital, Bageshwar valley	5-8000
d)	*Zingiber*	3	1				
	i) *Z. capitatum* Roxb.	-	-	Y	Aug.	Sarju valley	3500
	ii) *Z. chrysanthum* Rosc.	-	-	Y	Aug.	Mohar ganj	3-4500
	iii) *Z. officinale* Rosc.	-	-	Gr/Pr	-	Nainital outer hills	1-4000

EFFECT OF PERIOD OF HARVEST ON THE YIELD AND QUALITY OF OIL OF MENTHA CITRATA EHRH

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Amongst various Mentha species, Mentha citrata holds a prominent place in the perfumery, cosmetics, soap and flavour industry due to its linalool and linalyl acetate contents in the oil. It has been introduced in the tarai of Nainital district by Gulati et. al in the year 1969. Cultivation of Mentha citrata is being extended in the Tarai area of Nainital district. Owing to its successful cultivation, different aspects of its Agro-techniques are being studied at the Farm of CIMPO Regional Centre, Haldwani. This paper shows the study made on the effect of period of harvest on the yield and quality of the oil of Mentha citrata.

METHODS AND MATERIALS

A field trial was conducted at the Farm of CIMPO Regional Centre, Haldwani, located near G. B. Pant Agricultural University, Pantnagar in randomized block design with a plot size 5 mts. x 4 mts. Five dates of harvest, i.e., 15th May, 1974, 30th May 1974, 14th June 1974, 29th June 1974 and 14th July 1974 (D_1, D_2, D_3, D_4 & D_5) were taken as treatments with four replications. Planting of stolons was done in rows 45 cm. apart on 10th January 1974.

Meteorological data recorded during the trial period are given in Table 1.

The soil of the field was loam type in texture having

Organic carbon	= 1.21 kg/ha.
Available phosphorus	= 67.3 kg/ha.
Available potash	= 230.0 kg/ha.
pH.	= 7.0 (Neutral)

To ensure sprouting of stolons, the plots were given pre-planting irrigation. Uniform fertilizer dose of 90 kg N/ha.,

60 kg P_2O_5/ha. and 40 kg K_2O/ha. were given to all the treatments. Of which 30 kg. N, 60 kg. P_2O_5 and 40 kg. K_2O per hectare was applied as basal dose at the time of planting. While remaining 60 kg. N/ha. was top dressed with irrigation in three equal split doses during the growth period of crop. Nitrogen was applied in the form of Urea while P_2O_5 and K_2O was applied in the form of super-phosphate and Muriate of potash respectively. The irrigation and weedings were given as and when needed in all treatments uniformly.

First harvest was done treatment-wise in all the plots and second harvest was done on 22.9.74 uniformly at one time. The distillation of harvested fresh herb crop was done in field distillation unit for the estimation of oil yield and oil content. Quality of oil was studied as per Indian Standard IS No. 529-1950. Yield of herb and oil per hectare are summarised in Table No. 3.

RESULTS AND DISCUSSION

Effect of period of harvest on the yield of herb

In the first harvest, yield of herb differed significantly in different treatments. Herb yield was maximum in D_3, i.e., 189.44 q/ha. followed by D_4 treatment, i.e., 187.50 q/ha. Perusal of data Tables 2 & 3 indicate that yield of herb increased with the advancement of growth period up to 155 days. Thereafter, a decreasing trend was noticed in the crop. This could be due to the fact that plants were in active growth stage up to 155 days. Thereafter, reproductive phase become active and lower leaves started shedding resulting in low yield of herb (i.e. 172.50 q/ha. in case of crop harvested at 185 days).

In case of second harvest, significantly higher yields of herb over other treatments were obtained in D_4 treatment (i.e. 190.54 q/ha.) followed by D_3 treatment (i.e. 182.68 q/ha.) i.e. after 85 and 100 days from the first harvest respectively. Harvesting of ratoon crop at 70 days, i.e., D_5 treatment, resulted in reduction of yield which was 160.68 q. herb/ha. only. This could be due to lesser period of growth of the plants.

Pooling the herb yield data of both the harvests it was observed that D_4-treatment gave significantly superior yield of herb, i.e., 378.04 q/ha. followed by D_3-treatment, i.e. 372.12 q/ha. whereas lowest yield of herb was observed in D_1-treatment, i.e. 286.10 q/ha. The reason for higher yield of herb seems to be that in case of treatment D_3 and D_4 the plants attained maximum growth resulting in the higher yield of herb in both the harvests.

Effect on yield of oil and oil content

In first harvest, oil yield differed significantly amongst all the treatments. Maximum oil yield was obtained in D_4-treatment, i.e., 58.12 kg. oil/ha. in 170 days age of crop followed by D_3-treatment, i.e., 49.32 kg. oil/ha. in 155 days age of crop. Lowest yield of oil was obtained in D_1-treatment, i.e., 26.14 kg/ha. which increased progressively up to D_4-treatment, i.e. 58.12 hg/ha. Yield of oil in treatment D_3 and D_5 was at par. This may be possibly due to the fact that in early stage of harvest, crop was immature giving poor yield of oil with low oil content, but with the progressive increase of plant age oil content was increased up to maturity stage thereafter the oil content decreased due to over maturity and increased stem to leaf ratio. Similar results have also been recorded by Gulati et. al. (1974) in Peppermint (Mentha piperita).

In case of second harvest the oil yield was maximum in D_4-treatment followed by D_3 treatment, i.e. 57.16 kg and 45.46 kg oil/ha. respectively, giving 0.27 per cent and 0.30 per cent oil content when harvested at the age of 85 and 100 days from first cutting whereas 70 days old crop yielded 38.56 kg. oil/ha. with low oil content, i.e., 0.24 per cent (on fresh weight basis). 130 days old crop gave lowest oil yield of 31.11 kg./ha. which might be due to over maturity of crop suffered due to prolonged moisture stress conditions during monsoon season which affected the vegetative growth phase and consequently lowered the oil yield.

Pooling the oil yield data of both the harvests it is seen from Table 3 that D_4-treatment yielded significantly higher oil yield, i.e., 115.28 kg./ha. followed by D_4-treatment (i.e. 94.78 kg/ha.) with 0.30 and 0.26 per cent oil content respectively.

Effect on quality of oil

The quality was determined in terms of free alcohols, i.e. linalool and results are given in Table 4. In both the harvests, treatment D_3 gave the maximum linalool content, i.e. 61.65 per cent and 63.05 per cent in first and second harvest followed by D_4-treatment, i.e., 60.80 per cent and 55.82 per cent respectively. In case of first harvest, the linalool content in D_1-treatment was lowest due to early stage of crop which increased with the progressive development of crop growth reaching maximum at D_3 treatment when the plants attained the age of 155 days. Thereafter, the linalool content was decreased. The data are in accordance with the findings of Gulati et. al. (1974).

In case of second harvest of crop, linalool content was also recorded maximum in D_3 treatment (i.e. 100 days of crop age).

But when the plant attained the age of 130 days, the linalool content was decreased, i.e., 47.65 per cent, which might be due to over maturity of crop. The linalool content was also low in D_5 treatment, i.e., 49.86 per cent probably due to immaturity of crop at the crop age of 70 days.

SUMMARY

From the observations, it may be inferred that for getting the maximum herb and oil yield with good quality of oil, the crop of Mentha citrata should be harvested between 155 to 170 days in first harvest and 85 to 100 days in second harvest under tarai climate of Nainital district.

ACKNOWLEDGEMENT

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REFERENCES

1. Guenther, E. (1949) — The Essential Oils. Vol. III. D. Van. Nostrand Company, Inc. New York, pp. 685-87.

2. Gulati, B.C. & Duhan, S.P.S. (1974) — "Essential Oil of Mentha citrata Ehrh". Paper presented for VI International Congress of Essential Oils held at Sanfrancisco, California, during 8-12 Sept.'74.

3. Gulati, B.C., Duhan, S.P.S. & Garg, S.N. (1974) — "Studies on the effect of period of harvest on the yield and quality of oil of Mentha piperita Linn." Paper presented in the Symposium on "Recent advances in the development, production and utilization of medicinal and aromatic plants in India" organised by CIMPO at CDRI, Lucknow, during 24-26 Feb.'75.

4. Todd, W.A. & Murray, M.J. (1968) — New Essential Oils from hybridization of Mentha citrata Ehrn. Perfumery & Essential Oil records. 59(2), 1968, 97-102.

Table 1

Meteorological Data Recorded during the Trial Period

Month & Year	Max. Temp. °C	Min. Temp. °C	Humidity % (AV.)	Rainfall m.m.
January 1974	21.6	6.4	69	-
February 1974	23.4	6.2	64	11.4
March 1974	30.3	9.6	55	4.0
April 1974	37.6	17.9	40	15.0
May 1974	39.1	21.3	40	10.2
June 1974	37.6	23.8	56	142.8
July 1974	32.2	24.2	81	418.5
August 1974	32.5	34.2	82	499.9
September 1974	33.3	22.8	75	61.0

Table 2

Showing the Date of Harvesting and Age of Mentha Citrata Ehrh

Treatments	Date of planting	Date of harvesting		Age of crop at	
		First	Second	First harvest	Second harvest
D-1	10.1.1974	15.5.1974	22.9.1974	125 days	130 days
D-2	10.1.1974	30.5.1974	22.9.1974	140 days	115 days
D-3	10.1.1974	14.6.1974	22.9.1974	155 days	100 days
D-4	10.1.1974	29.6.1974	22.9.1974	170 days	85 days
D-5	10.1.1974	14.7.1974	22.9.1974	185 days	70 days

Table 3

Effect of Different Harvesting Period on the Yield of Herb. Oil and Oil Content of Mentha Citrata Ehrh

Treatments	YIELD OF HERB/ha. (q)			YIELD OF OIL/ha. (kg.)			OIL CONTENT IN PERCENT (on fresh weight basis)		
	First harvest	Second harvest	Total	First harvest	Second harvest	Total	First harvest	Second harvest	Total
D-1	137.60	148.50	286.10	26.14	31.11	57.25	0.19	0.21	0.20
D-2	168.37	172.42	340.79	37.04	41.38	78.42	0.22	0.24	0.23
D-3	189.44	182.68	372.12	49.32	45.46	94.78	0.24	0.27	0.26
D-4	187.50	190.54	378.04	58.12	57.16	115.28	0.31	0.30	0.30
D-5	172.50	160.68	333.18	48.30	38.56	86.86	0.28	0.24	0.26
F' Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.			
S.Em.I	1.05	1.11	1.42	0.70	0.75	0.88			
C.D. at 5%	2.29	2.43	3.09	1.53	1.63	1.92			

Table 4

Physico-Chemical Properties of the Oil of Mentha Citrata Ehrh

Treatment	Harvests	Physico-chemical properties							
		Specific Gravity (30°C)	Refractive index (30°C)	Acid value	Easter value	Easter content (cal. as linalyl acetate)	Easter value after acetylation	Free alcohols (cal. as linalool)	Total alcohols (cal. as linalool)
D-1	First	0.8763	1.4605	1.13	75.01	26.24	214.18	45.56	68.25
	Second	0.8695	1.4675	1.75	85.54	30.19	225.74	47.65	71.17
D-2	First	0.8808	1.4645	1.28	47.26	16.76	219.59	56.49	70.48
	Second	0.8772	1.4680	2.31	78.72	27.78	240.62	54.44	76.08
D-3	First	0.8862	1.4655	0.60	64.6	22.5	248.00	61.65	80.60
	Second	0.8842	1.4645	1.85	80.48	28.40	264.50	63.05	85.18
D-4	First	0.8784	1.4710	2.41	76.60	24.92	255.55	60.80	81.86
	Second	0.8690	1.4615	1.64	85.54	30.19	250.54	55.82	79.34
D-5	First	0.8861	1.4695	2.12	80.72	28.49	225.54	47.88	70.07
	Second	0.8772	1.4690	1.42	80.54	28.43	230.64	49.86	72.00

THE ROLE OF *BOTRYODIPLODIA* IN THE DIE BACK OF *BURSERA* AND ITS CONTROL

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A number of investigators have reported canker and die back diseases caused by *Botryodiplodia theobromae* Pat. or allied fungi as there was a considerable confusion regarding the nomenclature of the pathogen. Ingram (1912) reported the fungus of canker and die back disease of chestnut as *Dothiorella* C. & Ell. Later (1914) she referred it as *Diplodia longispora* C. & Ell. But Rankin (1914) identified the same fungus as *Sphaeropsis malorum* Berk, Steevens and Speers (1933) as *Sphaeropsis quercina* C. & Eill and Moyce and Speers (1960) as *Dothiorella quercina* (C. & Ell.) Sacc. Schmidt and Fergus (1965) studied the problem of canker and die back of *Quercus primus* extensively and came to the conclusion that many authors have examined only one of the developmental stages of this fungus and identified as *Sphaeropsis, Dothiorella, Diplodia,* which in fact, as they conclusively identified, is a species of *Botryodiplodia*. From India, Williamson and Tandon (1966), Shreemali (1968) and a few others also have reported various diseases caused by *Botryodiplodia theobramae* Pat.

Sarwar et al. (1966) reported a severe die back of *Bursera delpechiana*, gave an elaborate account of the symptomatology and also indicated the probability of *Botryodiplodia* sp. as being the causative organism. Five more fungi were reported by Sarwar (1969) isolated from the different diseased samples of *Bursera*, but the problem of die back still remains obscure. The die back of *Bursera* was noted at many places especially in Karnataka and Andhra Pradesh where a fairly big percentage of the plants were found to be suffering from this disease. A detailed study of the disease was conducted at the CIMPO Farms, Bangalore where *Bursera* is under cultivation. After making observations on the etiology of the disease which is almost similar in all the affected areas, a fungus namely, *Botryodiplodia* sp. was most consistently isolated from the diseased samples. On the basis of its morphological characters, it is conclusively identified as *Botryodiplodia theobromae* Pat.

Botryodiplodia theobromae Pat.
Champignon's del-Equateur. Bull.
Soc. Mycol. Fr. 8 136-140. 1892.
Saccardo, Syll. Fung. 11, 522. 1895.
Sarwar, M. Angew. Botanik. 46. 257-262. 1973.

Colonies white when young turning olive grey to dark olive grey with age. Mycelium 1 - 1.5 μ broad, septate, hyaline to subhyaline, in culture Pycnidia gregarious in stromatic masses, but on the host they are borne singly 250-300μ in diameter, black ostiolate, erumpent, confluent. Conidiophores, simple, short, immature. Conidia hyaline, oviod with oil globules. Mature conidia dark brown broad, ellipsoid, medially septate, 2-celled usually constricted at the septum. Ends broadly rounded, thick-walled, 205 (-23.5) x 13 -(13.5)μ.

On living leaves and twigs of *Bursera delpechiana*, CIMPO, Devanahalli farm, Bangalore district, M. Sarwar, 20-12-1965. IMI 116147 - b. Herb. Mycol. Bangalore University, 437. CIMPO Herb. Mycol. Bang. 143.

Spore germination:

The germ tube appeared as a small protuberance after 5-6 hours of absorbing water. Very often 2 germ tubes, one each from the 2 cells of the spore emerged.

Longevity of the spores:

Longevity of the spores of *B. theobromae* was determined on the basis of viability of the spores by picking up pycnidia at regular intervals. It was observed that the percentage of germination of the spores decreased with age and after about one year no germination was noticed.

Pathogenesis:

The fungus was cultured on PDA and from three months old culture, spore suspension was made by mixing one slant in 100 ml. sterile distilled water.

For the pathogenicity test, 10 healthy, two year old potted plants were selected and kept in 2 groups - A and B of five each. Out of 5 plants of each group one was kept as control. Spore suspension was sprayed. It was later sealed with moist sterile cotton wool and taped. The region was surface sterilized with 70% alcohol (ethanol) previous to wounding.

After 3 weeks foliar symptoms started appearing on all the 4 plants of group B which later displayed the branch die back. The

plants of group A and the control of Group B remained unaffected.

No scale insect was allowed during the test. It shows there is less possibility of scale being involved in die back, which, at the most, may be having only a contributory role under the field conditions.

Table 1

	Method of inoculation	Time of appearance of die back	Percentage of infecction
1.	Spore suspension sprayed on uninjured branches	--	--
2.	Spore suspension sprayed on injured branches	25 days	100

It is evident that injury under experimental conditions was a pre-requisite for establishment of infection. The age of the host and the effect of environmental factors seem to play an important role in the germination and growth of *Botryodiplodia in situ*. Although die back was experimentally induced, typical defoliation, formation of pustules, etc., were either not there or they were noticed feebly compared to what was observed in the field.

However, from the artificially infected plants, re-isolation of *B. theobromae* was made; thus proving one of the important principles of Koch's postulates.

Control measures

Field trials were conducted in a randomised block of 36 x 17.5 m., at the CIMPO Farm, Bangalore Dist., with 4 fungicides listed in Table 2. To minimise the number of fungicides under test copper oxychloride was chosen to represent copper fungicide group. The plot was divided into 15 beds of 6.0x4.5 m. size and each bed had 12 plants on 1.5 x 1.5 m spacing. They were 3 years old. None of the plants had any apparent symptom of infection at the beginning of the trial.

Table 2

Fungicide	Active ingredient	Concentration	Intensity of infection at the end of the period
Blitox	Copper exychloride	0.5%	Light
Dithane	Zinc ethyline-bisdithiocarbamate	0.2%	Moderate
Benomyl	Methyl - 1 (Butyl-Carbamoyl-2-Benzimidazole carbamate)-50%	0.25%	Light
Bordeaux mixture	Copper sulphate and lime	0.8%	Moderate
Control	--	--	Very severe

The spray work was started from June, i.e., soon after the appearance of new foliage at 15 days interval till the month of February. Albolinium was used at 5 gms./10 litres as a sticker and spreader. Observations of disease intensity was recorded 15 days after the final spray on 4 plants/plot selected at random.

For all assessments a severity scale from '0' (no disease) to 5 (very severe disease) was used.

It was observed that Benomyl followed by Blitox and Bordeaux mixture gave good protection against die back.

Acknowledgments

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STUDIES ON THE FLORAL BIOLOGY AND THE PROBLEM OF SEED SETTING IN CITRONELLA

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Citronella is an aromatic perennial grass grown for its essential oil called "Citronella oil", which is widely used in soaps, perfumery, cosmetics, etc. There are two closely related species of Citronella viz., *Cymbopogon nardus* Rendle and *C. winterianus* Jowitt popularly known as Ceylon and Java Citronella respectively.

India has been importing considerable quantities of citronella oil and its indigenous production till recently has been very negligible. There are about 1600 hectares under Java citronella in South India today, mainly due to the efforts of the Central Indian Medicinal Plants Organisation (CIMPO), Bangalore and the country is reaching a stage of self sufficiency gradually in it. Considerable work is going on in the fields of Agronomy, Cytogenetics, Breeding, Plant protection, etc. for the improvement of this crop at CIMPO, Bangalore.

The present paper deals with the studies on the floral biology and the problem of seed setting in the four cultivars of Citronella.

Materials and Methods

The materials for the present study are (1) Ceylon *(C. nardus* Rendle); (2) Java I; (3) Java II and (4) Guatemala, cultivars (The last 3 cultivars are of *C. winterianus* Jowitt). They were planted at CIMPO Experimental Farms, Bangalore during December 1973, in separate adjoining plots and were provided with uniform conditions.

Fresh undehised exposed anthers were selected for pollen studies. For pollen fertility studies, the pollen grains were stained with acetocarmine and the pollen grains that had taken stain were considered as fertile. Different media were used for pollen germination studies and Brew Bakers medium was found to

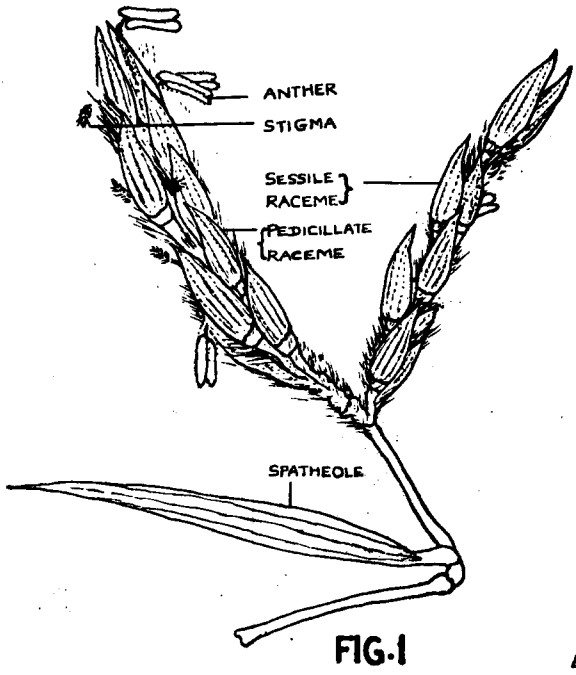

Fig. 1

A raceme pair of *Cymbopogon winterianus* showing a sessile and a pedicellate raceme with a spatheole

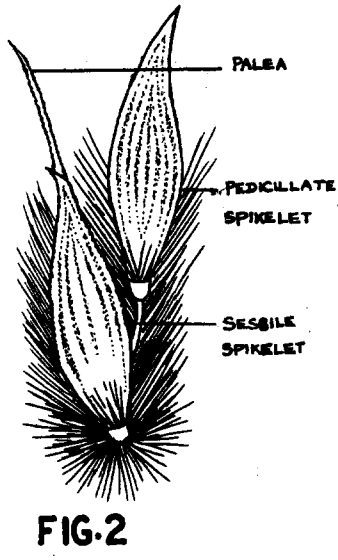

Fig. 2

A spikelet pair of *C. winterianus* showing a sessile and a pedicellate spikelet

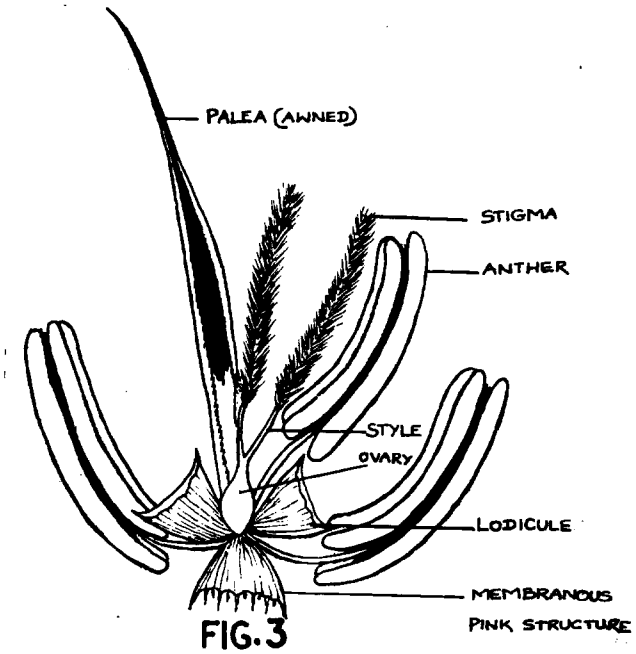

Fig. 3

A sessile spikelet of *C. winterianus* showing the details of floral parts after the removal

be suitable. For cytological studies of P.M.Cs, young spikelets were selected and fixed in acetic-alcohol (1:3) between 9 a.m. and 10 a.m. for 24 hours and smears were made in acetocarmine.

Observations and discussion:

I. Floral biology: The floral biology is found to be almost the same in all the four cultivars of Citronella and hence the following observations pertain to all the four cultivars in common.

a) Floral morphology: Basically, there are no great differences in the general floral morphology of the four cultivars. In Ceylon cultivar, the inflorescence is erect, stiff, compact and much congested. In the other three cultivars, the inflorescence is long, large, spreading and slightly penduleus.

Flowering shoots arise directly from the rhizome and bear 4-6 leaves alternately with a terminal paniculate inflorescence. The panicle is long (70-100 cm) consisting of a central axis with 10-12 nodes. 1-3 lateral branches arise at each node. These are long, penduleus, of purplish shade and give rise to further branching, finally bearing the racemes. The racemes occur in pairs, one sessile and the other pedicellate subtended by a spatheole (Fig. 1). Each raceme consists of paired spikelets (9-15 in number), one sessile and the other pedicellate (Fig. 2). The rachis and the pedicels are covered with long glittering hairs. Panicle is polygamous with 45% hermaphrodite, 50% male and 5% either female or barren flowers. Each spikelet is single flowered with two glumes, one lemma, one palea, two funnel shaped lodicules and one membrancus pink coloured structure arising at the point of the origin of lodicules. The sessile spikelet is usually hermaphrodite, rarely female, thicker, firmer and dorsally compressed. The pedicellate spikelet is always male, narrower and thinner than the sessile one. The lowest spikelet pair of the sessile raceme is always homogamous and male. The terminal sessile spikelet of the racemes bear two pedicellate spikelets. The palea of sessile spikelets is long, awned and projects out (Fig. 2 and 3). In pedicellate spikelets palea may be present or absent, if present, awn is not developed. Anthers dithecous, extrose and versatile. Ovary unilocular, superior, globose with one basal ovule and two feathery stigmas elevated on two separate styles.

b) Mode of flowering: The commencement of reproductive phase in citronella is indicated by the appearance of separate, tall flowering shoots. The flowering shoots usually arise between the months of September and October and give rise to 4-6 long leaves. The flowering shoot continues to elongate. When it reaches 2/3 of its maximum length, the lateral inflorescence branches start developing. It is then the panicle axis starts elongating. Along

with it, the lateral inflorescence branches also grow and give rise to further branching. This finally exposes the racemes. It takes 30-40 days for the completion of the above process. In another 7-10 days the blooming starts.

In Ceylon cultivar, flowering remains for a short time (middle of November to end of January). In Java II and Guatemala cultivars, it is relatively longer (beginning of November to end of January). But in Java I cultivar, flowering remains for a very long time (middle of November to middle of March) because of proliferation of flowering. About 80-95% of the old spikelets wither after flowering period in Ceylon, Java II and Guatemala cultivars. But in Java I, the old spikelets do not wither for a long time and the inflorescence exhibits a fresh look because of prolific flowering. Later these flowering shoots gradually start bending by loosing their stiffness. The Ceylon Java I and Java II cultivars flower profusely. But in Guatemala only 10% of the clumps flower with only 2-5 flowering shoots, per clump. This is a very good trait needed for the breeder because the flowering has a tendency to supress the vegetative growth in Citronella and thereby reducing the yield of oil.

c) Anthesis: Usually it takes 4-6 days for blooming to be completed in a single panicle. The maximum number of spikelets open between 3rd and 4th days, and exclusively in the early morning hours between 6.0 a.m. and 9.0 a.m. The opening of spikelets is from top downwards in the panicle as well as in its lateral branches. The opening starts in the pedicellate raceme first from tip to base, followed by the sessile raceme later. The hermaphrodite flowers open first, and before the emergence of anthers and stigmas of hermaphrodite flowers reaches the base, the second flush of emergence of anthers from staminate flowers starts.

In a spikelet, first the glumes begin to open due to the swelling of the lodicules. The filaments of the stamens and styles of the gynoecia elongate rapidly so as to expose the anthers and feathery stigmas. First, the staminal column appears, enclosing the stigmatic branches. Next the anthers tilt down and become pendant. Stigmas come out later. The entire process is carried out in 3-5 minutes. Afterwards, the glumes gradually close and do not open again. After anthesis, the lodicules loose turgidity. Few minutes after emergence, the anthers dehisce along the longitudinal sutures tip downwards and shed pollen on the feathery stigmas. The anthers dry up in about a day and very soon the stigmas also start drying.

II. Seed setting: Amongst the four cultivars of Citronella here, only Ceylon cultivar is setting viable seeds and plants also have been raised from the seeds. But Java I cultivar seems to set very few viable seeds and the phenomenon of vivipary has been

recorded in Java I cultivar. But in Java II and Guatemala cultivars, the seed setting has not been observed so far.

The investigations conducted and the results obtained, to assess the causes of sterility are given below:

i) Pollen fertility: About 80-85% of the pollen grains took the acetocarmine stain indicating a good amount of apparent pollen fertility.

ii) Pollen germination: About 70-75% of the pollen grains germinated in Brew Baker's medium.

The pollinated stigmas when observed under microscope showed many germinating pollen grains with long pollen tubes.

iii) Cytology of P. M. Cs: The meiotic studies of the P. M. Cs do not reveal any chromosomal abnormalities. The meiosis is found to be normal.

The observations on the ovaries showed signs of their development after pollination. But they dry out at different stages of their development.

Based on the above studies, it seems logical to eliminate the possibility of male sterility in connection with seed setting. The available evidences also point out to the ovary as the place to look into the problem of sterility in seed setting. The studies on this aspect are in progress.

Acknowledgment:

The authors are grateful to Shri M. N. A. Khan, Manager, CIMPO, Bangalore for his interest and encouragement throughout this investigation. The senior author (C. R. K.) is thankful to the Council of Scientific and Industrial Research for the award of Fellowship.

INDIAN KHUS (VETIVERIA ZIZANIOIDES Staff.) AND THEIR SCOPE IN ESSENTIAL OIL INDUSTRY

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Vetiveria zizanioides staff.(Khus) is an important essential oil yielding plant of India. Vetiver oil is extensively used in making perfumes, medicine, soap and other toilet articles. The Vetiver is a perennial grass, densely tufted, upright, growing luxuriantly on rich, marshy soil attaining a height of 1 to 2 metres with root portion branching into spongy aromatic fine root-lets. It grows in large clumps, the leaves of which are long, erect, narrow, stiff with high margins up to one metre in length. The Vetiver plant has a long terminal panicle carrying numerous slender re-ceme of spikelets.

Many of the cultivated types rarely flower and the flowers that are seen on some, rarely set seeds. The leaves of the plant are odourless and do not contain any essential oil. It is the root which gives the essential oil, and is strongly scented. The length of the root varies from 10 to 35 cm and some time even more.

Distribution

The Vetiver grass is native of India. It is found throughout the plains and lower hills of India, Burma and Ceylon. It is seen growing wild throughout the Punjab and Uttar Pradesh, in jungle tracts ascending into the Kumaon Hills, on the banks of rivers and lakes and in the district of Bharatpur in Rajasthan. In central India, it is seen partly growing wild and partly cultivated. It is also found in Baroda, Chota Nagpur, Bihar and Assam. The plants also grow wild in parts of east and west coast of India. The plant is cultivated in certain places of Kerala, Tamil Nadu, Karnataka and Andhra Pradesh. However, the bulk of the oil and roots are obtained through wild plants.

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Varieties

According to Rao, I.K.S. (1966), there are two main types of Vetiver, one seeding and the other non-seeding. The one that grows wild in north India is seeding type, while that of south is non-seeding. There is also a considerable difference between the north Indian and the south Indian strains with regard to the yield and aroma of the oil. The oil of Bharatpur, Akila and Musanagar strains has superior aroma than south Indian strains. However, the yield of south Indian types is higher.

The Vetiver is propagated from seeds or slips. Seeding is found to be profuse in the crop, in the areas where it occurs wild, and regeneration takes place from self-sown seeds and by tillering during and after the rains. In the south where the crop is cultivated on large scale, the non-seeding type is grown. This is propagated from slips obtained from the uprooted clumps of the previous crop. Slips separated from the clumps with the rhizome portion intact having 15 to 20 cm of the shoot portion constitute the material for planting.

Soil and Climate

The Vetiver can be grown in almost every kind of soil, a rich and fairly well drained sandy loam is considered the best. It grows luxuriantly in places with annual rainfall of about 1000 to 2000 mm and temperature ranging from 21°C to 44°C and with moderately humid climate. It grows best in rich marshy soils in warm and damp climate and grows sturdier with fine matty roots. The heavy yield of roots and high oil content obtained in these places are due to the good depth, texture and fertility of the soil. Chandra V, et al (1968) reports that the Vetiver can be grown in saline and alkali soils with pH range of 8.5 to 10.1.

Planting

Vetiver is planted in rows 4.5 cm apart. Distance from plant to plant being 25 cm. Planting is usually done in the rainy season. If irrigation facilities are available it is better if the planting is done in March-April. However, in that case frequent irrigation will be required. Two to three slips are planted in each hole 5 to 8 cm deep and the soil pressed firmly around the hole. Three to four weedings are necessary. Irrigation are given whenever necessary. The following 15 strains of Vetiver were received through the courtesy of the Project Coordinator (Aromatic & Medicinal Plants), I.A.R.I., New Delhi. Their performance was tested at the Division of Horticulture, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, during 1974-75. The comparative performance is given below:-

Comparative Economic of Khus Cultivation

Sl. No.	Strains	Dry root yield in kg/ha.	Percentage of essential oil by lab. est.	Yield of essential oil in kg/ha. by commencial method	Gross income in Rs/ha at Rs.600/- kg. of essential oil	Net profit in Rs./ha.
1.	Hyb. clone-3	4752	2.05	47.5	28,500	22,700
2.	Hyb. clone-2	4588	2.05	45.9	27,540	21,860
3.	Hyb. clone-14	4089	2.20	40.9	24,540	19,268
4.	Hyb. clone-11	3771	1.95	37.7	22,620	17,604
5.	Hyb. clone-15	3681	2.05	36.8	22,080	17,136
6.	Hyb. clone-6	3410	2.05	34.1	20,460	15,732
7.	Hyb. clone-23	3299	2.30	33.0	19,800	15,160
8.	Hyb. clone-7	3184	2.00	31.8	19,080	14,436
9	Hyb. clone-12	3136	2.05	31.4	18,840	14,328
10.	Hyb. clone-5	3129	2.00	31.3	18,780	14,276
11.	Hyb. clone-26	3026	2.15	30.3	18,180	13,702
12.	Hyb. clone-8	2945	2.10	29.5	17,700	13,340
13.	Hyb. clone-4	2842	2.00	28.4	17,040	12,768
14.	Hyb. clone-16	2812	2.00	28.1	16,860	12,612
15.	Sel. 55-2	2798	2.00	28.0	16,800	12,560

It is evident from the above table that hybrid clone-3 gave the highest dry root yield of 4752 kg./ha. closely followed by Hyb. clone-2 which gave an overall yield of 4588 kg./ha. Whereas sel 55-2 gave the lowest yield of 2798 kg./ha. Percentage of essential oil varied from 2.3 in Hyb. clone 23 to 1.95% in Hyb. clone-11 by laboratory estimation. However, by commercial method actual recovery of essential oil is about one per cent only. Hyb. clone-3 gave a gross profit of Rs.28,500/ha at Rs.600/- per kg. of essential oil and an overall net profit of Rs.22,700/ha after deducting cost of distillation at Rs.80/- per quintal of dry roots and cost of cultivation at Rs.2,000/- per ha. Hyb. clone-3 and 2 seems to be quite promising under conditions prevailing in Uttar Pradesh.

Acknowledgment:

The authors are thankful to Prof. K.N. Kaul, Vice-Chancellor, C.S.A. University of Agriculture and Technology Kanpur for encouragement in conducting the experiment and also to Dr. Rajendra Gupta, Project Coordinator (M. & Ar. Pl) I.A.R.I., New Delhi for supplying the plant material.

Abstract

Vetiveria Zizanioides Staff. (Khus) is an important essential oil yielding plant of India and its oil is extensively used in making perfumes, medicines and toilet articles. It is a perennial grass and its aromatic roots yield essential oil. There are two types of Vetiver, one seeding and the other non-seeding type. The one that grows wild in north India is seeding type while that of south is non-seeding. It is propagated from seeds and slips. It can be grown in almost every kind of soil including saline and alkaline soil with a pH range of 8.5 to 10.1. Fifteen strains obtained from the Project Coordinator (Aromatic and Medicinal plants), I.A.R.I., New Delhi were put to preliminary test at the Division of Horticulture, C.S.A. University of Agriculture and Technology Kanpur. Hybrid clone-3 and Hyb. clone-2 were found to be the most promising strains and they gave an overall dry-root yield of 4752 and 4588 kg./ha respectively. Whereas, sel. 55-2 gave an yield of 2798 kg./ha only. Oil percentage varied from 2-3 in Hyb. clone-23 to 1.95% in Hyb. clone-11. By Khus cultivation, a net profit of Rs.22,700 per hectare can be obtained. Khus cultivation can be adopted by Uttar Pradesh farmers for perfume and profit.

References

Chandra V, Singh A & Kapoor L.D. (1968). Experimental cultivation of some essential oil bearing plants in saline soils. Perfume. Essential. Oil. 59: 869-73.

Rao I K S (1966) Vetiver, the aromatic plant of the East. Ind. Farmi. 16: 31: 18-20.

SKIMMIA LEAF: A POTENT SOURCE OF ESSENTIAL OIL FROM HILL AREAS OF UTTAR PRADESH

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Skimmia leureola S & Z (Fam: Rutaceae) is an aromatic shrub growing wild at higher elevations in western Himalayas. The leaves of this plant yield an oil containing up to 65 per cent of linalyl acetate, a much used perfume material. Apart from this the oil resembles French petitgrain bigarade oil in physico-chemical properties and may find use as substitute to the latter which is presently being imported from abroad. A techno-economic evaluation of utilization of the naturally available raw material for production of Skimmia leaf oil revealed great potentialities in the States of Jammu and Kashmir, Himachal Pradesh and Uttar Pradesh. The plant grows over a very wide area in Uttar Pradesh, especially in the middle and inner Himalayan ranges of Jaunsar, Garhwal and Kumaon. Commercial exploitation of the raw material available from these areas may not only provide the Indian perfume and cosmetic industry with a valuable essential oil but may also contribute to the economic betterment of hill people in far flung areas of the State.

The raw material

Skimmia leureola is an evergreen shrub, 1 to 3 metre high, with oblong, lanceolate, leathery leaves, greenish yellow flowers and deep orange fruits. Whole plant emits a strong smell typical to Citrus family. The plant is locally known as Kedarpatta, Kasturchara or Nora in Jaunsar, Garhwal and Kumaon. It occurs commonly under oak-conifer forests and around "bugyals" (alpine meadows) at altitudes between 2400 m and 3200 m (above mean sea level). It is an evergreen shrub, but the leaves usually get detached during snowfall in winter months. Fresh leaves appear during the spring months of March to May and the plant is full of mature leaves by June. The collection period is spread over six months viz., from June to November. Coppice in the month of June enables a second harvest during October. The leaves are either distilled fresh or air dried to lose up to 60 per cent of

Table I

Yield of oil and variations in various geographical oil samples

Locality	% Oil (dwb)	n_D^{20}	d^{20}	$(a)_D^{20}$	% Linalyl acetate	% Linalool
Gulmarg, Kashmir	2.20	1.4664	0.9183	-4°75,	39.81	27.76
Ronshi, Kashmir	1.88	1.4644	0.8189	-4°75,	56.84	21.17
Sonamarg, Kashmir	2.95	1.4700	0.8974	-4°75,	59.62	19.16
Bunier, Kashmir	1.78	1.4670	0.8969	-4°55,	62.45	17.93
Bhalesh, Jammu	2.28	1.4645	0.8948	-4°75	60.14	19.73
Kishtawar, Jammu	2.00	1.4646	0.8949	-4°75,	61.31	19.35
Sannaser, Jammu	2.45	1.4616	0.8938	-4°45,	64.33	18.90
Trikuta, Jammu	2.00	1.4670	0.8958	-4°65,	61.89	18.90
Bhandal Chamba	2.20	1.4568	0.8940	-4°50,	59.38	21.70
Chakrata Jaunsar	1.65	1.4764	0.9136	-4°50,	59.15	22.35
Begeshwar Kumaon	1.40	1.4805	0.9124	-	40.13	28.17
Nainital Kumaon	1.36	1.4777	0.9142	-4°8,	54.37	24.37
Uttarkashi Garhwall	1.66	1.4750	0.9168	-4°75,	55.38	22.37

(Essential oil obtained by hydrodistillation of leaf only.)

moisture if transport to long distances is desired. Difficulties are encountered in obtaining desired air dry material due to the unsatisfactory climatic conditions prevailing in areas situated above 2500 m elevations. A quick transport of the material to distillation site is necessary in such cases. The wet material should not be stored for more than 3 to 4 days as fermentation leads to the deterioration of quality of the oil.

The yield and properties of the oil

The leaves with young twigs (about 20%) yield between 0.6 to 0.8 per cent of clear bluish oil when freshly distilled. The yield of oil in air dried material ranges from 1.7 to 2.0 per cent. A representative sample of oil obtained through steam distillation gave following physico-chemical properties:

Specific gravity at 20°C	- 0.8955
Optical rotation at 20°C	- -40 45'
Refractive index at 20°C	- 1.4606
Total esters calculated as linalyl acetate	- 65.18%
Free alcohols calculated as linalool	- 17.3%
Solubility in alcohol	- 1 in 2.3 parts.

A thin layer chromatographic examination of the oil revealed that the oil in addition to linalyl acetate and linalool contains pinene, β phellandrene, β citral, methyl heptenone, geraniol, bergaptene and four unidentified components. The oil content in the leaf samples obtained from various localities ranges from 1.36 per cent to 2.95 per cent (d.w.b.). The physico-chemical properties and ester and alcohol content also show slight variations (table I). A seasonal variation chiefly in the concentration of linalyl acetate and linalool has also been observed (table II). The yield of oil is maximum during the month of May and again during August. After August the yield of oil declines gradually. The concentration of linalyl acetate is maximum in the month of May and September. The proportion of linalool is correspondingly decreased during these months. The decline in the yield of oil or ester content is, however, not very great.

Commercial production of oil

The oil is obtained through steam distillation as that produced by hydrodistillation is of poor olfactory properties. For bulk distillation the material is well packed in stills in lots of 5 to 10 qtls (5 qtls of material requires a still of 1500 litres capacity). Steam at 40 to 50 lb pressure is injected and the distillate collected at the rate of 60 to 70 litres per hour. The entire distillation process is complete within 6 hours. The oil floating on the sur-

Table 2

Variations in the yield and physicochemical properties of Skimmia leaf oil collected during different seasons

Date of collection	% oil (dwb)	N_D^{20}	d^{20}	$(a)_D^{20}$	Solubility in alcohol pa	% Linalyl acetate	% Linalool
10th April, 1965	2.10	1.4616	0.8938	-5°75,	1 in 2.3	64.33	18.90
20th May, 1965	2.45	1.4640	0.8940	-4°48,	1 in 2.3	67.38	18.40
29th June, 1965	2.41	1.4670	0.8944	-4°75,	1 in 2.3	54.38	26.33
8th August, 1965	2.37	1.4674	0.8949	-4°45,	1 in 2.3	53.20	26.70
17th September, 1975	2.05	1.4685	0.8932	-4°80,	1 in 2.3	66.40	16.40
27th October, 1965	2.00	1.4685	0.8997	-4°45,	1 in 2.3	51.30	24.30
8th December, 1965	2.00	1.4649	0.8938	-4°45,	1 in 2.3	50.90	18.90

(Samples between 8th December 1965 and 10th April 1966 were not collected due to snowfall.)

face of the distillate in the oil receiver is removed periodically. The air dried material gives an average yield of 1.5 per cent of oil. Similar samples on hydrodistillation in the laboratory give 1.8 per cent yield.

The distillation centres should preferably be located at a place not more than 50 to 60 kilometres from the growing areas. Difficulties are sometimes encountered in transporting the material from places situated far away from the motor road heads. Field distillation is the best solution in such cases. A portable distillation unit consisting of a distillation still of 250 kg. capacity, and a wood-cum-coal-cum-oil fired portable boiler to give 100 kgs of steam per hour is used for this purpose. The fresh material is well packed in the steam distillation still. Steam is injected from the bottom at the rate of 50 kg per hour. The vapours containing oil and steam are condensed in a condenser and the two immiscible phases, water and oil are separated in a separator and oil collected in a separate tank. The entire distillation operation is complete within 5 hours. The average recovery of oil under field distillation is 0.4% to 0.5%.

Scope for commercial exploitation

Skimmia laureola has a very wide distribution in the hill areas of Uttar Pradesh. Though no detailed survey of the resources in the State has been done yet, reconnaissance in certain parts of Dehradun, Uttarkashi, Chamoli, Almora and Pithoragarh districts has revealed that the supplies of Skimmia leaf from these places may far exceed those available in Jammu and Kashmir or Himachal Pradesh. The leaf crop being renewable, there is no chance of natural stock getting depleted.

There is a good market for Skimmia leaf oil in the country. Large quantities of linalyl acetate and petitgrain bigarade oil are imported every year from France, Paraguay and other countries. The above studies have led to the commercial production of this oil for the first time in the country by Drug Research Laboratories, Srinagar (Kashmir). The oil has found ready acceptance by a number of leading firms in the country and is being sold at about Rs 240/- per kg. There is a great scope for producing this oil in Uttar Pradesh as sufficiently large quantities of the raw material are available in the hill areas.

The author is grateful to Dr. C. K. Atal, Director, Regional Research Laboratory, Jammu, for his keen interest in this project.

References

1. Guenther, E.: The essential oils. Vol. III, D. Van Nostrand Co., New York, 1930.
2. Kapoor, K.K., Sarin, Y.K. and Atal, C.K.: Perf. essential oil. Rec. 57, 424, 1966.
3. Sarin, Y.K.: Perf. & Kosmetic 52, 37-40, 1971.

THE POTENTIALS AND DEVELOPMENT OF ESSENTIAL OIL SOURCES FROM THE FORESTS OF UTTAR PRADESH

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Abstract

Special position of forests in Uttar Pradesh providing opportunities for occurrence and collection of a large number of plants with potentials for manufacture of essential oils in the State has been discussed. The availability of important essential oil plants in the forest of Uttar Pradesh is mentioned. The role of essential oils in the economy and development of State has been characterised. Future development and research concerning their planned exploitation and collection has been analysed.

Introductory

Resources are a foundation for a country's progress and power, Forests probably constitute a perpetual source of resources an inexhaustible and renewable mine of a large number of useful and basic products providing us a great potential for development of essential oil resources in Uttar Pradesh.

The State of Uttar Pradesh is luckily blessed with a matchless wealth of aromatic plants due to its varied climatic and edaphic conditions right from the tropical to the extreme temperate. The Himalays, Indo-Gangetic Valley and the Vindhyan tract in the Southern portion provide a variety of soil and climatic conditions most suitable for aromatic plants which are many in number and varied in character. The State due to favourable conditions best owed by nature, provided exceptional potential for occurrences development and cultivation of aromatic plants as compared to other States having uniform conditions of altitude and climate etc. An outline map of the State appended to this note showing district boundaries and distribution of various forest types illustrates cosmopolitan nature of its flora extending from alpine areas in the

Himalayas through the Tarai belt and upper Gangetic plain to the northern fringes of Vindhyas and Bundel Khand.

The number of plants which have markedly aromatic properties is small as compared with the species in the flora of the State. But the importance of a study of aromatic plants to a developing State of Uttar Pradesh which is well known in respect of essential oil yielding flowers, grasses and wood and where essential oil industry is one of the oldest, cannot be under-rated. The State is rich in aromatic and essential oil bearing plants.

The use of aromatic substances in cosmetics, culinary preparations, for masking agents of disagreeable odours in manufactured goods and as a component of countless goods of trade, is an overgrowing field and required the perfume and flavouring industry to remain in constant search of new perfumes and flavours and specially for plant species which yield aromatic materials. For this, tapping of non-traditional indigenous plant resources has assumed great importance in recent years. Essential oil which are imported as well as exported, play an important role in our national economy.

II. Availability of Important Essential Oil Bearing Plants in the State

The State of Uttar Pradesh has been historically a pioneer in perfume industry in India and has been mainly responsible for development of perfume and flavouring industries in the country. Manufacture of essential oils, attars, perfumed waters, etc. has been carried out in the State from times immemorial. The aromatic products and high class perfumes of the famous centres of production in the State situated at Kanauj, Ghajipur, Jaunpur, Aligarh and Lucknow, etc. have earned a popularity and great repute for their aroma and quality in far-off countries.

Improvement and additions to the existing matters of natural resources, extraction of essential oils and modernisation of equipment, will go a long way towards progress of this important industry in the State more so when introduction of synthetic essential oils and aromatic chemicals which are cheaper in cost and have an aroma similar to those of natural oils, has revolutionised essential oil industry and has thereby thrown a challenge to our costly traditional perfumes of great repute. A search for non-traditional natural plant resources is vitally indicated if our perfume industry has to survive and compete with others.

An exhaustive list of important oil bearing plants occurring in the State forests is reproduced as Appendix II to this note. Although part played by essential oils in life of plants is somewhat obscure probably connected with matabolism, fertilisation and protection

against enemies, it is present in intercellular spaces or in oil sacs in the plant. Any or all parts of plant may contain essential oil. Essential oils are found in buds flowers, fruits, fruit shalls, seeds, roots and rhizomes, bark stem, wood leaves and in some trees in eleo-resins exudate. Essential oil in conifers is present in all parts of plant. Essential oil in differs from vegetable and fatty oils in their chemical composition though both are products of vegetable kingdom. Essential oils are volatile odoriferous oils of vegetable kingdom. Distinction should however be made between the natural flower oils obtained by enflourage or solvent extraction and essential oils recovered by distillation.

Role of Essential Oils in Economy and Development of State

From dawn until twilight and long into night and from cradle of the infant to the silence of the grave we are surrounded by odorous materials. Perfumes in one form or the other are a part or things we see, touch, eat, wear and smell. We take odors granted and little we realise how much we would be affected if our lives are deprived of perfumes.

The early incenses were mixtures of ground spices held together by myrrh or storax. The next advance was the discovery that if certain species and flowers were steeped in fat or oil, the fat or oil would retain portion of odoriferous principle giving us the ointment and fragrant unguents of Biblical fame. Next was steam distillation of volatile essential oils followed by introduction of synthetics.

The perfume and flavouring industries although seemingly small, are vita because they are necessary components of countless goods whose annual turn-over involves millions of dollars. The use of perfumes as masking agents of disagreeable odors in manufactured goods ranging from adhesives to rubber articles, is an evergrowing field and leaving synthetic perfumes apart, the natural aromatic products have an annual sale probably involving million dollars.

Formerly all products used in perfumery were of natural origin and synthesising materials were used only to duplicate the finest of nature but now the "Fantasy perfumes" merely pleasing to the senses with no exact counterpart in the floral kingdom, have received wide acceptance. The art of perfumes is of extreme antiquity. Finest modern perfumes are neither wholly synthesised nor completely natural. Best product of the art is a judicious blend of the two in order to enhance the natural perfumes to reduce the price and to introduce new note of fragrance into the enchanting gamut at present available. Products made solely of synthetics tend to be coarse and unnatural.

The application of essential oils is very extensive and covers a wide range of human activity. Important uses to which they are put are as ingredients in the manufacture of soaps, cosmetics, perfumes, medicines, pharmaceuticals, plastic goods, textiles, leather, confectionery, perfumed tobacco, pan-masala, rated waters, syrups, disinfectants, insecticides, fungicides, deodarants, detergents, paints, dehydrated foods, icecreams, baby foods, biscuits, paper writing pads and cards etc. Citral - an isolate of lemon grass oil, is used in preparation of vitamin A.

Perfumes are not articles of luxury now as it was thought in time bygone. Importance of essential oils is increasing day by day with the advancement of education prosperity in the country. Fragrance plays a vital role in securing consumer's acceptability in almost every product that he uses. Fragrance is not a luxury item. It is now a basic raw material for consumer products of mass consumption. Even farmers are now growing essential oil bearing plants and using perfumes in larger quantities. Perfumery raw materials besides isolates and pure chemicals consist of natural oils which are essential oils, flower concentrates, absolutes and oleoresins. At least two hundred essential oils are used often and eight hundred find casual applications. Similarly about a dozen expressed oils and a dozen flower absolutes and a few oleoresins and gum resin oils are used. Production in India including Uttar Pradesh of perfumery based products is worth several crores of rupees. India exported in 1974-75 about Rs 92,762 thousands worth of essential oils and perfumery oils mainly Eucalyptus oil, Zinger grass oil, lemon grass oil, plasmarosa oil, sandal wood oil, vetiver oil and many others besides crude plant products like henna leaves and powder, agarbattis, kuth roots, sandal wood chips and dust, perfumes, attar and aqueous lotions. But unfortunately we import a large quantity of various essential oils such as oil of citronella, menthol, oil, patchouli, begamot, clove, lavender, lemon and peppermint oils for our perfume and flavouring industries. To check this import of this essential oils and perfume aromatics worth crores of rupees, time is mature for planned development, systematic extraction, extensive cultivation and vigorous research in the field of essential oils. We should not be complacent about our export items and should harness our knowledge and resources to meet the challenge of synthetics and imports and to restore the lead of our State and the country in the field of aromatics and perfumery in the world. With the expanding population and the higher standard of living for all in the socialist pattern of society the aromatics and the perfume industry has an important role to play.

Research and Development

History of essential oil is perhaps the history of human civilization in good old age. India and our State in particular enjoyed

a pre-eminent position of manufacturers of superior perfumes and aromatics and leading suppliers of essential oils and perfumes to the world. But today we have been superseded by western countries, Gutemala and China etc. in the open market probably because of inefficient organisation, lack of research, unplanned exploitation of natural resources, failure to grow them on a large scale, moving with advance in time in our method of processing and lastly due to malpractices and adulteration. We are, with the passage of time, instead of exporting perfumes, importing perfumes from other countries for our home consumption. It is unfortunate that with almost all types of climate and soil existing in our State in particular and our great country in general, the possibilities of raising large scale plantations of essential oil bearing plants on scientific lines has not been explored. It is a pity that vast stretch of forests blanks and lands termed as barren, waste and marginal, are being allowed to remain idle whereas they can be usefully employed to raise aromatic raw materials.

Essential oil bearing plants grow in forests widely distributed and scattered running a serious danger of hybridisation with other inferior species. In order to obtain the products of good uniformity and to improve quality of the plant material etc., it is imperative that systematic exploitation and extensive cultivation on scientific lines be undertaken on top priority basis. Research is necessary to explore new plants and to develop new strains of plants to meet the challenge of synthetics. The prime need of the day is to give an impetus for a systematic and organised effort for plantation and cultivation of valuable aromatic plants and grasses on a commercial basis and inducing cultivators and farmers to utilise all the barren and vacant land to grow them. Next is the introduction of modern and up-to-date equipment for scientific processing of essential oils from the basic vegetable raw materials. The researcher has to note that perfumes are no more a monopoly of Princes, Dukes and rich persons. Perfumes are required by masses now, the entire consuming pattern of aromatic has now changed with the change in social order specially in our State and the country. The price range has to be considered so as to be within easy reach of the masses. The consumer trend for a particular perfume has to be considered.

Research pertaining to cultivation, manufacture and storage of essential oil is also essential. Modern methods of distillation and further utilisation of essential oil have to be evolved. The State has a vast potential for aromatic materials. Selected plant species yielding valuable essential oils have to be profitably cultivated and raw material resources of the State have to be adequately expanded. There is much scope for scientific development, conservation, collection, extraction and planned raising of large scale

plantations of essential oil bearing plants. The production has to be put on an organised footing and systematically augmented. The entire concept of treating essential oil bearing plants as minor forest items, has to be changed with the development pattern of changed social structure and the changed consumer pattern.

Concluding Remarks

The State of Uttar Pradesh has all types of climates, soils, lands and population conducive to the growth of a variety of essential oil bearing plants and grasses. The prime need of the hour is to give an impetus to scientific research, intensive cultivation and improved processing. The import of so many essential oils and export of valuable raw materials as such, must be stopped by developing substitutes from indigenous resources and export of finished perfumes. A coordination of activities of scientists, botanists, foresters, agriculturists, chemical manufacturers, chemists, growers, farmers, agronomists, perfumers and planners is most desirable for harmonious development of perfume industry in order to restore the past grandeur of the State and the country in the field of perfumes in the world. They should all join hands, do some hard thinking and take a rational approach towards a long term planning to improve the national natural resources of aromatic plants and important industries based on them and thereby improve the economy of the State, taking into consideration the changed pattern of social structure and consuming pattern. The perfume is no more a monopoly of rich. These are used by masses now in their daily life. It forms an important ingredient of almost every product used by man.

The State forests have been a main source of supply of aromatic plants and grasses but with the expanding population and higher standard of living what is required is to itensify and to regulate not only collection of what occurs naturally but to improve on it by resorting to systematic planting.

A proper appraisal of the potential resources of essential oil bearing plants is a must. We should not be complacent about our export items but should harness our knowledge and resources to meet the challenge of synthetics to check the import of various essential oils and stop export of basic aromatic raw material as such. Production of appealing fragrances at lower cost and in much larger quantities for production of better consumer goods are the prime needs of the people for their economic uplift. On the food front flavours have to be provided to make new nutrients, vegetable proteins and processed foods more acceptable to masses.

We should harness and utilize the natural resources to the betterment of humanity, and developing high yielding varieties of

aromatic plants and raise intensive plantations of the same to help economy of this poor State.

All the above would surely make us more self-sufficient and shall open wide scope for export too.

APPENDIX

ESSENTIAL OIL BEARING PLANTS OF UTTAR PRADESH FORESTS

No.	Species	Common name	Part used	Essential oil content, %
1	2	3	4	5
1.	Abies pindrow spach	Talis patra	D	-
2.	Acacia arabica Willd.	Babul	F	-
3.	Acacia farnesiana Willd.	Gadbabul	F	-
4.	Acorus calamus Linn.	-	-	-
5.	Aegle marmelos Corr.	Bel	D	-
6.	Ageratum conyzoides Linn.	Dochunty	D, F	-
7.	Alangium salviifolium (Linn. f.) Wang.	Akola	F	-
8.	Anemone obtusiloba D. Don.	Rataniota	A, B	-
9.	Anemone rivularis Ham.	-	A, B	-
10.	Anemone vitifolia Ham.	-	A, B	-
11.	Anethum sowa Kurz.	Sowa	B, J	3-3.5
12.	Annona squamosa Linn.	Sharifa sitaphal	D	-
13.	Anthocephalus cadamba Miq.	Kadam	F	-
14.	Aristolochia bracteata Retz.	Kiramar	B	-
15.	Artemisia maritima Linn.	Atsameen	-	-
16.	Atalantia monophylla (Roxb.) DC.	-	-	-
17.	Blumea aromatica DC.	-	D	-
18.	Blumea lacera DC.	Kakrenda	D	-
19.	Boswellia serrata Roxb.	Salai, Luban	M	9
20.	Brassica campestris Linn.	-	B, J	-
21.	Cannabis sativa Linn.	Bhang	A	-
22.	Carum carvi Linn.	Shiajira	I	2
23.	Capparis spinosa Linn.	-	F, J	-
24.	Cassia fistula Linn.	Amaltas	F	-
25.	Cedrela toona Roxb.	Tun	L	0-44
26.	Cedrus deodara (Roxb.) Loud.	Deodar	L	-
27.	Cinnamomum camphora (Linn.) Nees & Eberm.	Carpura	D	-
28.	Cinnamomum zeylanicum Blume	Tamal patra	D, O	2

1	2	3	4	5
29.	Citrus medica Linn.	Bara nimbu	P	-
30.	Crotalaria burhia Buch.Ham.	Booi	-	-
31.	Cupressus torulosa D. Don.	Leuri	D,I	-
32.	Curcuma amada Roxb.	Amhaldi	C	1.1
33.	Curcuma aromatica Salsib.	Janglihaldi	C	6.1
34.	Cymbopogon flexuosus Nees ex. stud. Wats.	Lemon grass	D,G	-
35.	Cymbopogon jwarncusa Schult.	Jarakush	D,G	-
36.	Cymbopogon martini var. Motia Roxb.	Gandheighas	D,G	-
37.	Cymbopogon martini var. sofia Wats.	"	D,G	-
38.	Cymbopogon nardus Linn. Rendle	Ganini	D,G	-
39.	Cymbopogon polyneuros Stapp. f.		D,G	-
40.	Cymbopogon scholenanthus Linn. Spreng.	Rosa grass	D,G	-
41.	Cyperus rotundus Linn.	Motha	N	0.5
42.	Cyperus scariosus R. Br.	Nagar motha	N	0.075 - 0.08
43.	Dalbergia sissoo Roxb.	Shisam	L	-
44.	Daphne papyracea Wall ex. steud.	Mahadevkaphool	F	-
45.	Dolichos lablab Linn.	Sem	B, J	-
46.	Elsholtzia cristata Willd.	--	A	0/931
47.	Ervatamia divaricata Linn. Alston	Chandni	F	-
48.	Eucalyptus citriodora Hook	Eucalyptus	D	0.5 - 2
49.	Eucalyptus globulus Labill.	"	D	0.9 - 1.25
50.	Eucalyptus hybrid	"	D	0.6 - 2.85
51.	Eupatorium odoratum Linn.	"	D	-
52.	Hedychium spicatum Ham. ex. smith	Kapur kachri	C	4
53.	Hemidesmus indicus R. Br.	Magroboo	B	0.225
54.	Inula cappa (Ham.) DC.	-	B	-
55.	Inula cuspidata clarke	-	B	-
56.	Inula rubricaulis clarke	-	B	-
57.	Jasminum arborescens Roxb.	Chameli	F	-

1	2	3	4	5
58.	Jasminum disperrnum Wall.	Chameli	F	-
59.	Jasminum grandiflorum Linn.	"	F	-
60.	Jasminum humile Linn.	Malti	I	-
61.	Jasminum officinale Linn.	-	-	-
62.	Jasminum pubescens Willd.	Chameli	F	-
63.	Juniperus macropoda Boiss.	Dhup	I	-
64.	Juniperus squamata Buch-Ham.	Guggal	I	-
65.	Juniperus communis Linn.	Aarr.	I	0.8-1.0
66.	Lantana camara Linn.	-	D	-
67.	Lawsonia inermis Linn.	Mehndi	F	-
68.	Litsea chinensis Lamk.	Maidalakhri	D,I	-
69.	Litsea elongata Wall.	-	D,I	-
70.	Litsea lanuginosa Nees.	-	D,I	-
71.	Litsea polayantha Juss.	-	D,I	-
72.	Litsea umbrosa Nees.	-	J	-
73.	Mangifera indica Linn.	Aam	D	-
74.	Melia azadirachta Linn.	Buckain	D,I	-
75.	Mentha arvensis Linn.	-	D	-
76.	Mentha piperita Linn.	Pudina	D	0.5-1.5
77.	Mentha viridis Linn.	"	D	-
78.	Mimusops elengi Linn.	Moolsari	F	-
79.	Moringa oleifera Lam.	Sajna	J	-
80.	Murraya koenigii (Linn.) Spreng.	Kathnim	D,F	-
81.	Murraya paniculata (Linn.) Jack	Bisar	F	-
82.	Myrtus communis Linn.	Vilayati mehdi	D	-
83.	Nardostachys jatamansi DC.	Jatamansi	C	-
84.	Nepeta hindostana Roth Haines	Kamal	D	-
85.	Nerium indicum Mill.	Kaner	B	-
86.	Nyctanthes arbor-tristis Linn.	Harsingar	F	-
87.	Ocimum americanum Linn.	Kala tulsi	D,G	0.6
88.	Ocimum basilicum Linn.	Davna	D,G	-
89.	Ocimum gratissimum Linn.	Ramtulsi	D,G	6.13
90.	Ocimum kilimandscharicum Guerke	Kapur tulsi	D,G	-

1	2	3	4	5
91.	Ocimum sanctum Linn.	Tulsi	D, G	0.7
92.	Pandanus tectorius Soland. ex. Parkinson	Keora	F	-
93.	Pinus roxburghii Sargent	Chir	D, L	-
94.	Pinus wallichina A. B. Jack.	Kail	D, L	-
95.	Piper brachystachyum wall.	Paharipipal	B, I	-
96.	Pipar longum Linn.	Pipal	B, I	-
97.	Prunus cornuta (Wall.) Steud.	Jamoi	K	-
98.	Prunus cerasoides D. Don	Padam.	K	-
99.	Pistacia integerrima Stewart ex. Brandis	Kakkar	-	-
100.	Premna barbata Wall.	Bakar	D, B	-
101.	Premna herbacea Roxb.	Bharangi	D, B	-
102.	Premna latifolia Roxb.	Bakar	B, D	-
103.	Premna scandens Roxb.	Bharangi	B, D	-
104.	Psoralea corylifolia Linn.	Babchi	J	-
105.	Putranjiva roxburghii Wall.	Putranjiva	C	-
106.	Ranunculus aquatilis Linn.	-	A, B	-
107.	Ranunculus arvensis Linn.	-	A	-
108.	Ranunculus sceleratus Linn.	Shini	A	-
109.	Rheum emodi Wall.	Ravanchini	C	-
110.	Rosa involucrata Roxb.	Kuchata	F	-
111.	Rosa macrophylla Lindl.	Kajoi	F	-
112.	Rosa moschata Herrm.	Kujoi	F	-
113.	Rosa sericea Lindl.	-	F	-
114.	Santalum album Linn.	Safed chandem	L	1.5-6
115.	Sarcococca pruniformis Lind.	Tiliari	D	-
116.	Saussurea lappa clarke	Kuth.	B	-
117.	Seseli indicum W. & A.	Baniwan	I, J	-
118.	Shorea robusta Gaertn.	Sal.	M	-
119.	Skimmia laureola Sieb & Zucc. ex Walp.	Nehar	D	-
120.	Sphaeranthus indicus Linn.	Mundi	A, D	-
121.	Syzygium cumini Linn.	Jamun	D	0.013-0.02
122	Thuja orientalis Linn. Skeels	Morpankhi	B	95
123.	Thymus serphyllum Linn.	Banjwan	D, I	0.5
124.	Tylophora himalica Hook. f.	-	D, A	-
125.	Tylophora hirsuta Wight	-	D, A	-

1	2	3	4	5
126.	Valeriana wallichii DC.	Muskbala	B	0.5-2.12
127.	Viola serpens Wall.	Banjasha	B, F	-
128.	Zanthoxylum acantho-podium DC.	Tumra	I, J	
129.	Zanthoxylum alatum Roxb.	Tejbal	I	1.5
130.	Zanthoxyeum ovalifo-lium Wight	-	C	-
131.	Zingiber zerumbet Rosc. ex Smith	-	C	-
132.	Zingiber roseum Rosc.	-	C	-

Abbreviations Used

A - Whole plant
B - Roots
C - Rhizome
D - Leaves or needles
E - Stems
F - Flowers
G - Flowering tops
H - Twigs
I - Fruits
J - Seeds
K - Fruit kernel
L - Wood
M - Gum - resin
N - Tubers
O - Bark
P - Peel

Bibliography

1. Ames, O. (1905-1920). Orchidaceal.
2. Bedoukian, P.Z. (1951). Perfumery Synthetics and Isolates, D. Van Nostrand Company Inc., New York.
3. Bor, N.L. (1941). Common grasses of United Provinces, Indian Forest Records.
4. Bose, K.C. (1932). Pharmacopeia Indica.
5. B.P.C. (1949). The British Pharmaceutical Codex.
6. Brandis, D. (1921). Indian Trees.
7. Chopra, R.N. (1933). Indigenous Drugs of India.
8. Chopra, R.N., Chopra, I.C., Handa, K.L. and Kapoor, L.D. Chopra's Indigenous Drugs of India.
9. Chopra, R.N., Chopra, I.C., and Verma, B.C. (1969). Essential Oil Bearing Plants. I.Sc. Ind. Res.
10. Chopra, R.N. (1952). Essential Oil Bearing Plants I.Sc. Ind. Res.
11. Chopra, R.N. (1958). Indigenous Drugs of India. U.N. Dhar and Sons, Calcutta.
12. Clarke, A. (1922). "Flavouring Materials, Natural and Synthetic" Hodder and Stoughton Ltd., London.
13. Collet, H. (1921). Flora Simalensis.
14. Crocker, E.C. (1945). Flavour-Mc Gram Hill.
15. C.S.I.R. (1942-1952). Wealth of India (Dictionary of Raw Materials and Industrial Production) Vol. I-IV.
16. De Navarre, M.C. (1941). The Chemistry and Manufacture of Cosmetics D. Van Norstrad Company Inc. New York.
17. Development of Essential Oil Industry in U.P. (1958). Harcourt Butler Institute, Kanpur.
18. Dhanvantari Visheshak. (1971). Parts I, II, III, IV and VI.
19. Dollard, W. (1880). Medical Topography of Kumaon and Shone Valley.
20. Duthie, J.F. (1803-1922). Flora of Upper Gangetic Plains and of the adjacent Siwalik, and Himalayan Tract.
21. Dutt, S. (1940). New Indian Essential Oils. Indian Soap J. 6
22. Gildemeistor, E. and Haffman, Fr. (1936). Volatile oils Vol. II. Longmans Green & Co., London.
23. Gildemeister and Haffman. (1912). The Volatile Oils.
24. Grisso, M. (1933). Cullbary Herbs and Condiments, London.
25. Guenth, E. (1949-1952). The Essential Oils, 6 Vols. Van Fortsand & Co. Inc., New York.
26. Guenther, Dresct. (1948). "The Essential Oils" 6 Vols. D. Van Fortsrand Co. Inc., New York.
27. Gupta, B.L. (1927). Forest Flora of Chakrata, Dehra Dun and Saharanpur Forest Division.
28. Gupta, R.K. (1967). Seasonal Flora of the Indian Summer Essorts, Mussorie Hill, London.

29. Gupta, R.K. (1962). Flora Nainitalonsis.
30. Hill, A.P. (1937). Economic Botany, MacGraw Hill, London.
31. Hooker, J.D. (1896). Flora of British India.
32. Holman, E.J. (1940). Insecticides material of vegetable origin, the Imperial Institute London, Chapman & Hall, London.
33. Jacobs, M. (1947). Synthetic Food Adjuncts, D. Van Estrand Co. Inc., New York.
34. Kirke, R.E. and Othmer, D.F. (1947-1956). Encyclopedia of Chemical Technology.
35. Kirtikar, K.R. and Basu, D.D. (1935). Indian Medicinal Plants, V Vols.
36. Krishna, G. and Badhual, B.L. (1947-1955). Aromatic Plants of India J. Co. Ind. Res.
37. Krantj and Carr. (1958). Pharmacologic Principles of Medical Practices, Willian and Willkins Company Baltimore.
38. Mehra, P.N., Bhatnagar, J.K. and Handa, H.S. (1970). Research in Pharmacognosy in India.
39. Menon, A.K. (1960). Indian Essential Oil, A Review CSIR, New Delhi.
40. Mukerji, B. (1953). The Indian Pharmaceutical Codex. Vol. I Indigenous Drugs, CSIR.
41. Nadkarni, K.M, (1927)Nadkarni, M.M. (1934). Indian Materia Medica.
42. Nayar & Chopta (1931). Distribution of British Pharmacapoeial Drugs Plants and their Substances Growing in India.
43. Naves, R, Mamujer, G. (1939-1947). "Les parfuma naturals" Gantheir Villars & Cic. Paris, Translated E. Sagarin, Rein hold Publishing Corporation, New York.
44. Norris and Shreve, R. (1956). The Chemical Process Industries (Asian Students Edition) MC Garam Hill Book Company Inc. New York & Ko Gokunha Company Ltd. Tokyo.
45. Camoston, A.E. (1927). A Forest Flora of Kumaon.
46. Fearson, R.S. and Brown, H.P. (1932). Commercial Timbers of India.
47. Poucher, W.A. (1942). Perfumes Cosmetics and Soaps, 2 vols. D. Van Fostrand Company Inc., New York.
48. Sadgopal. (1942). Important aeromatic raw materials of India.
49. Sagarin Edward. (1945). The Science and Art of Perfumery MC Graw-Hill Book Company, Inc., New York.
50. Santapau, H, Mensy, A.N. (1973). A Dictionary of the Flowering Plants in India.
51. Sarin, J.L., and Beri, M.L. (1931). Northern India Essential Oils.
52. Singh, B.W. (1939). Perfume and Essential Oil Yielding Plants of India.
53. Singh, Ram Sushil. (1969). Benaushaiadhi Nirdeshika.
54. Sinha, R.L. (1961). Sandal in Bundelkhand Forest Division, Uttar Pradesh. Indian Forester Oct. 1961.

55. Sinha, R.L. (1975): Distribution and Availability of Medicinal Plants in the Hills of Uttar Pradesh - National Symposium on Recent advances in the Developments, Production and Utilization of Medicinal and aromatic plants.
56. Sinha, R.L. (1975): Protection and Planned Exploitation of Indian Medicinal Plants in the Hills of Uttar Pradesh - National Symposium on Recent Advances in the Development, Production and Utilization of Medicinal and Aromatic Plants.
57. Sinha, R.L. (1975): A retrospect on poisonous plants in the forests of U.P. - International Symposium on Industrial Toxicity, Lucknow.
58. Sollmon, T. (1936): A Manual of Pharmacology.
59. Sudborough, J.J. (1918-20): Indian Essential Oils.
60. Sratchey and Winterbottom: Catalogue of Plants of Kumaon.
61. Uphoe, J.C. Th. (1954): Dictionary of Economic Plants.
62. The American (periodical) Perfumer: The Robbins Perfume Company Inc., New York.
63. Tressler, D.K., Joslya, M.A. and Marsh, G.L.(1939): Fruit and vegetable juices. Avi Publishing Co., Inc., New York.
64. Trotter, H. (1940): Manual of Indian Forest Utilization, London.
65. Wahid, Rahim, Abdul Siddique, H.H. (1961): A survey of drugs.
66. Waring (1968): Pharmacopeia of India.
67. Watt. (1869-99): Dictionary of Economic Products of India, 6 Vols.
68. Watt, G. (1908): Commercial Products of India.
69. White, R.C. (1964): Grassland and Fodder Resources of India of ICAR, New Delhi.
70. Willis, J.C. (1955): A Dictionary to the Flowering Plants and Ferns.
71. Wren, R.C. (1941): Potter's Cyclopaedia of Botanical Drugs and Preparation.
72. William, A. Pauc er (1959): Perfumes, Cosmetics and Soaps, Vol. I to III, London.
73. William and Schillid (1959): Applied Pharmacology J.& R. Churchil Ltd., London.

SPACING EFFECT ON THE HERBAGE AND OIL YIELD IN CAMPHOR TULSI (*Ocimum Kilimendscharicum Guerk*) IN SALINE-ALKALI SOILS

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No work has been reported on the spacing of *Ocimum Kilimandscharicum* in saline alkali soils. A lot of work has been done on spacing in other crops which indicate that spacing plays very important role and influences various growth, yield and quality contributory characters. In order to determine optimum spacing of camphor tulsi in saline-alkali soils, a spacing trial was laid out in a randomised block design having four replication[3] during the year 1967-68 and 1968-69 at Aurawan sub-centre of Research Station Banthra of National Botanic Gardens, Lucknow. Net plot size of experimental bed was 4 M x 4 M and various plant populations per square meter maintained were 2, 4, 6, 8, 10 and 12 plants.

Material and Methods

Six plant populations viz. 32, 64, 96, 128, 160 and 192 plants per plot (4M x 4M) were tested in a randomised block design having four replications. Seeds were sown in nursery on 15th July. Seed rate of 100 gms gave enough seedlings to transplant one hectare of land. Summer ploughing of experimental field was done by tractor. F.Y.M. @ 10 tons/hectare was added in the field in the month of July. Four ploughings and plankings were done by bullocks to have suitable seed bed in the second week of August. Transplanting in the experimental beds was done on 10th September. Phosphorus and potash was applied @ 105 kg/hectare before transplanting in furrows. Ammonium sulphate was topdressed in four split doses to supplement nitrogen @ 175 kg/per hectare, first after one month of planting and remaining after every cutting. Gap filling was done after 15 days. First weeding and hoeing was done after 40 days of transplanting. Subsequent hoeings were done after every month. First harvesting was done after 90 days, i.e. on 10th December and remaining after 60 days viz. 10th February, 10th April and 10th June. Composite soil samples were taken before fertilizer application for soil analysis.

Observations

Data regarding growth contributory characters viz. length of stem, spread, fresh and dry weight per plant were taken just before every harvest. Variation range in respect of length of stem was between 30 cm to 150 cm. Variation range in respect of spread was 225 sq.cm. (15 cm x 15 cm) to 2000 sq.cm. (50 cm.x 40 cm). Variation in the ratio of fresh and dry weight was between 3 : 1 to 4 : 1. Experimental field was alkaline and poor, having pH range of 8.5 to 9.5, organic carbon 0.25% and electrical conductivity 0.8 mmhos/cm. Herbage yield per plot was recorded at the time of harvesting on the basis of fresh weight. Details of herbage yield, plotwise and yearwise is shown in Fig. I.

Results and Discussion

Variation in the average yield per plot of *Ocimum Kilimendscharicum* was from 3.375 kg. (32 plants per plot) to 8.500 kg. (128 plants per plot) in the first cutting, 11.250 kg. (192 plants per plot) to 25.000 kg. (96 plants per plot) in the second cutting, 11.000 kg. (32 plants per plot) to 23.250 kg. (96 plants per plot) in the third cutting and 6.250 kg. (192 plants per plot) to 14.500 kg. (96 plants per plot) in the fourth cutting during 1976-68. Similarly variation in the average herbage yield per plot was from 3.500 kg. (32 plants per plot) to 9.000 kg. (128 plants per plot) in the first cutting, 12.750 kg. (192 plants per plot) to 26.000 kg. (96 plants per plot)in the second cutting, 16.500 kg. (32 plants per plot) to 35.000 kg. (96 plants per plot) in the third cutting and 7.250 kg. (192 plants per plot) to 21.250 kg (96 plants per plot) in the fourth cutting during 1968-69.

Study of the analysis of variance table indicates that variation in the herbage yield per plot due to various plant populations per plot was highly significant in all the four cuttings during both the years of 1967-68 and 1968-69. Plots having total population of 96 plants, i.e. 6 plants per square meter gave significantly highest yield of herbage and consequently oil also. While plots having total population of 32 plants, i.e. 2 plants per square meter gave significantly lowest yield of herbage and oil during both the years of experimentation.

Further study of the Fig. I and Fig. 2 indicates that plant population @ 6 plants per square meter gave herbage yield of 11,090 kg. per hectare during 1967-68 and 14,220 kg. per hectare during 1968-69 which gave 66.540 kg. and 85.320 kg. camphor oil during both the years respectively while plant population @ 2 plants per square meter gave herbage yield of 5430.00 kg. and 6410.00 kg. per hectare during 1967-68 and 1968-69 which gave 32.580 kg. and 38.460 kg. camphor oil per hectare. Similar was the trend in case of ultimate product, i.e. camphor.

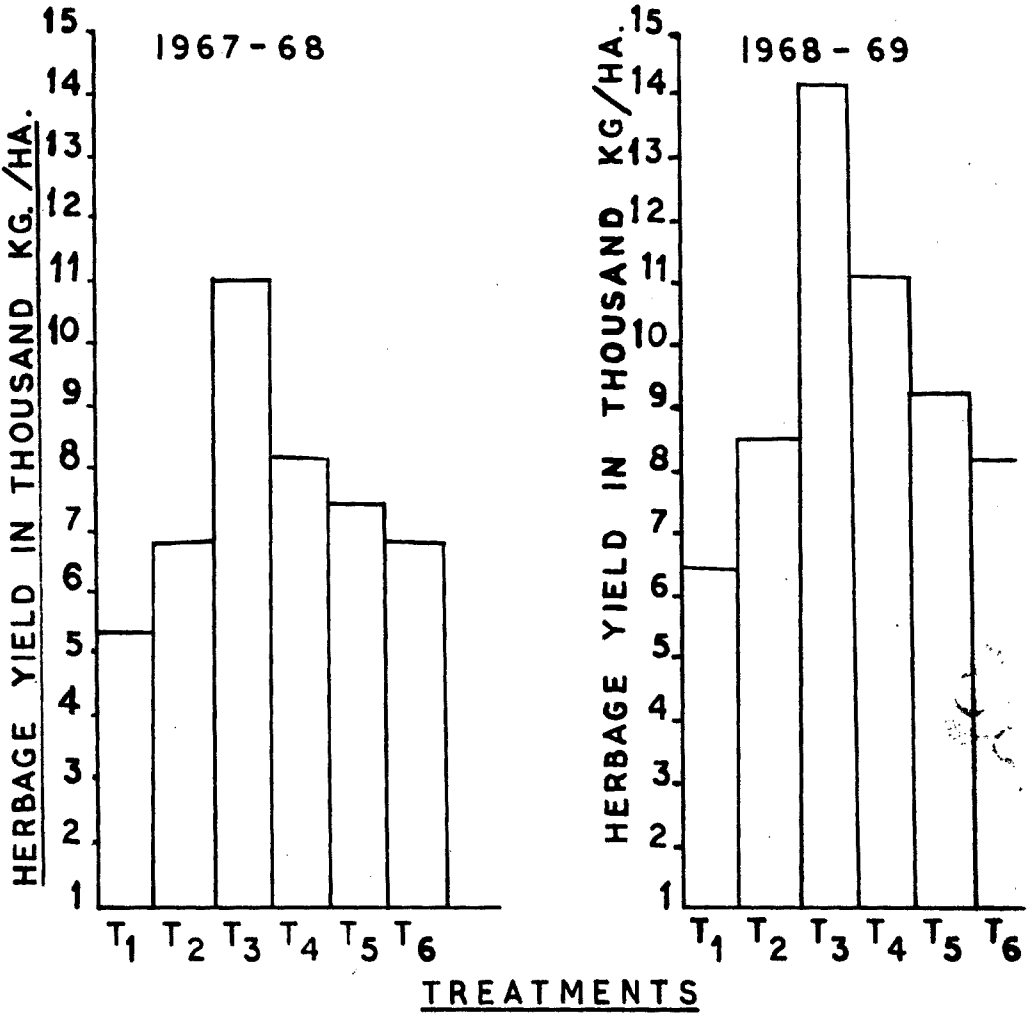

FIG.1. SHOWING TREATMENTWISE YIELD OF HERBAGE PER HECTARE IN KG.

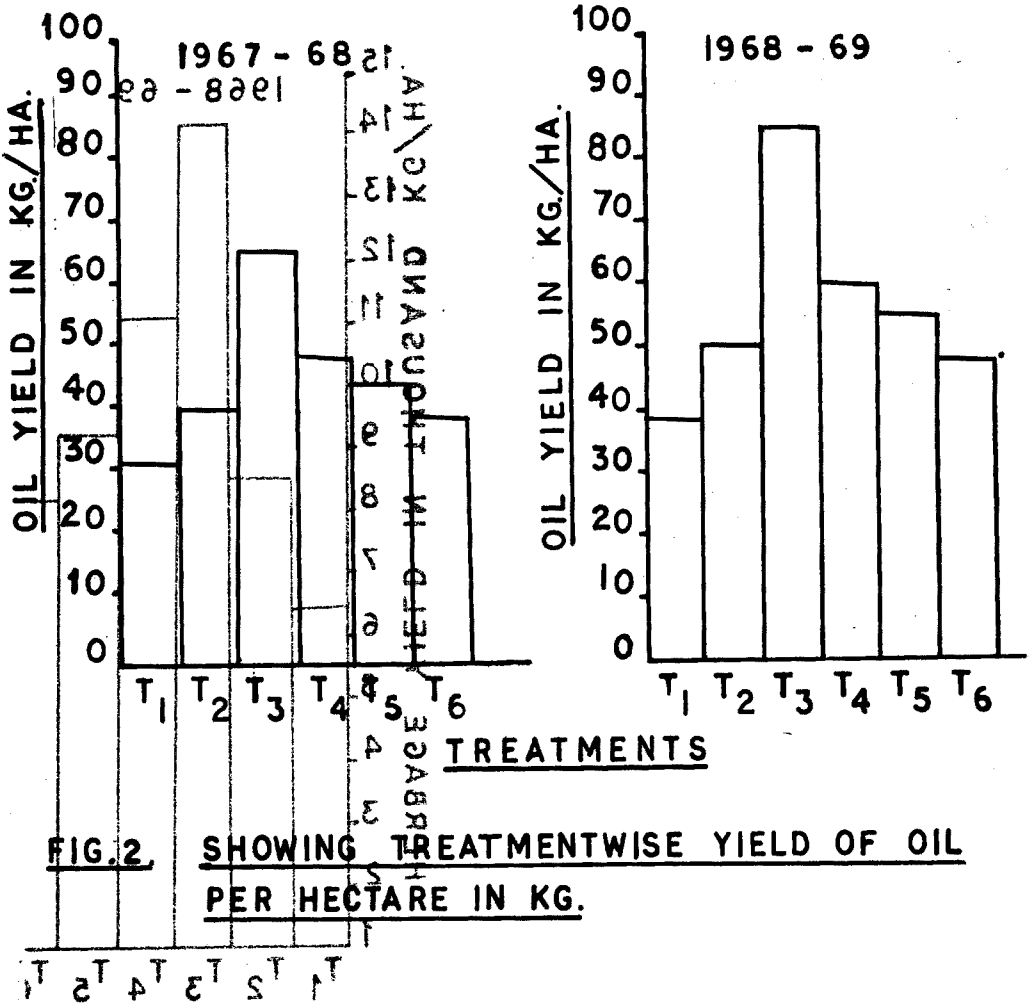

FIG. 2. SHOWING TREATMENTWISE YIELD OF OIL PER HECTARE IN KG.

Conclusion

It is thus concluded that optimum spacing for camphor tulsi in saline-alkali soils is 6 plants per square meter. Too much or least plant populations do not have higher herbage and oil yield of camphor tulsi (Fig. I and Fig. 2). Thus this spacing is recommended for saline-alkali soils. Various plant populations do not affect the quality of camphor and its oil (Singh and Sharma 1970).

Acknowledgment

Author is grateful to Director, National Botanic Gardens, for providing necessary facilities for this work.

References

1. Abrol, I.P, Dargen, K.S. and Bhumla, D.R. (1973). Reclaiming alkali-soils. Tech. Bull.2 (Agri. Series) I.C.A.R., New Delhi.

2. Sharma, M.L., Pandey, M.B., Khanna, R.K. and Kapoor, L.D. (1972). Essential oils raised on alkaline soils. Indian Perfumer, Vol. XVI Part II p. 27-30.

3. Singh, L.B., Sharma, M.L. (1970). Camphor from the oil of Ocimum, Kilimandscharicum raised on alkaline soils. Reichstoffe Aromen Octo. 1970. p.389-90.

4. Pandey, M.B. (1974). Agronomical studies in niger (Guizotia abyssinica) in saline-alkali soils. Ph.D. Thesis, Kanpur University, Kanpur.

EFFECT OF NPK ON HERBAGE YIELD OF CAMPHOR TULSI (*Ocimum kilimendscharicum* Guerk) IN SALINE ALKALI SOILS

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There are about 7 million hectares of salt effected soils (Abrol and Bhumla 1971) in India. In U.P. alone the area under these soils comprises about 1.295 million hectares. These soils are waste due to high salt concentration and high alkali reaction. Such soils can be corrected by three methods viz., physical, chemical and biological. Physical and chemical methods being expensive and less effective can not be adopted on large scale while biological methods which include addition of organic matter and growing of salt tolerant crops etc. though slow but are least expensive and more effective and can be adopted on large scale. *Ocimum kilimendscharicum* Guerk is one of the salt tolerant crops which can be successfully grown on saline alkali soils even up to 9.5 pH. Seeing its good performance in saline alkali soils a manurial experiment was laid out to find out its manurial requirement for getting maximum yields during the year 1967-68 at Aurawan Sub-Centre of Research Station Banthra of National Botanic Gardens, Lucknow (U.P.).

Material and Methods

Eight doses of nitrogen, phosphorus and potash each at the rate of control, 25:15:15, 50:30:30, 75:45:45, 100:60:60, 125:75:75, 150:90:90 and 175:105:105 kg. per hectare were tested in a randomised block design having three replications. Seeds were sown in nursery on 15th July. Seed rate of 100 grams gave sufficient seedlings to transplant one hectare land. Summer ploughing of the experimental field was done by tractor. In the month of July, Farm Yard Manure at 10 metric tons per hectare was added in the field. In the second week of August field was ploughed and planked by bullocks four times to get fine seed beds. Seedlings were transplanted on 1st September. Spacing of 45 cm x 40 cm was maintained between row to row and in between rows respectively. A light irrigation was given after transplanting. Gap fillings was done after 15 days of transplanting. First

weeding and hoeing was done after 35 days of transplanting. Subsequent hoeing were done after every month. Phosphorus was applied as basal dressing before transplanting, viz. at the time of fourth ploughing in furrows. Potash was broadcast one month after transplanting. Nitrogen was applied in four split doses, i.e. first after 30 days of transplanting and remaining three after every harvest. First harvesting was done after 90 days, i.e. on 1st December and remaining after 60 days, viz. 1st February, 1st April and 1st June. Composite soil sample was taken before application of fertilizers.

Observations

Data regarding growth contributory characters, viz. length of stem, spread and fresh and dry weight per plant were taken just before every harvest. Variation range in respect of length of stem was between 40 cm to 120 cm per plant. Variation range in respect of spread was 300 square cm. (20 cm x 15 cm) to 1200 square cm. (40 cm x 30 cm). Variation in the ratio of fresh and dry weight was between 3:1 to 4:1. Experimental field was alkaline having pH range of 8.5 to 9.5, organic carbon 0.22% and electrical conductivity 0.8 mmhos/cm. Herbage yield per plot was recorded at the time of harvesting on the basis of fresh weight. Details of herbage yield, plotwise and yearwise is shown in Fig. 1.

Results and Discussion Average Herbage

Variation in the yield per plot of *Ocimum kilimendscharicum* was from 3.056 kg (Control) to 5.471 kg. (175:105:105) in the first cutting, 14.783 kg (Control) to 24.066 kg. (175:105:105) in the second cutting, 11.733 kg. (Control) to 27.000 kg. (175:105:105) in the third cutting and 18.166 kg. (Control) to 34.166 kg. (175:105:105) in the fourth cutting during 1967-68. Similarly variation in the average herbage yield per plot was from 8.000 kg to 15.500 kg. in first cutting, 41.000 kg to 85.100 kg insecond cutting, 32.200 kg to 101.00 kg in third cutting and 59.00 kg to 104.00 kg in the fourth cutting respectively.

Analysis of variance table indicated that variation in the herbage yield per plot due to various treatments is significant in the fourth cutting during 1967-68 and in all the four cuttings during 1968-69. Reasons for insignificance during 1967-68 in the first three cuttings may be attributed to the slow rate of availability of nutrients supplied to the plants as it disappeared after fourth cutting and continued up to second year of experimentation in the same field. Fertilizer dose at the rate of 175:105:105 NPK each per hectare gave significantly highest yield of herbage over all the other treatments.

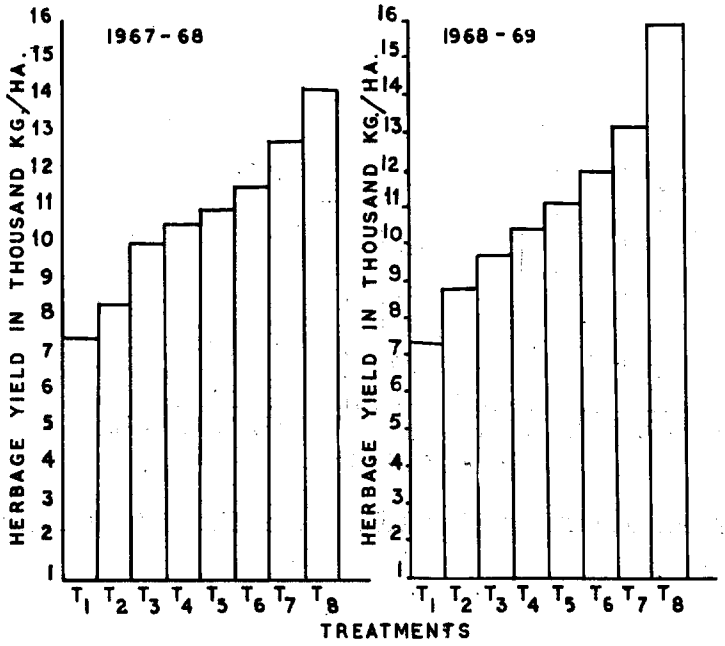

FIG.1. SHOWING TREATMENTWISE YIELD OF HERBAGE PER HACTARE IN KG.

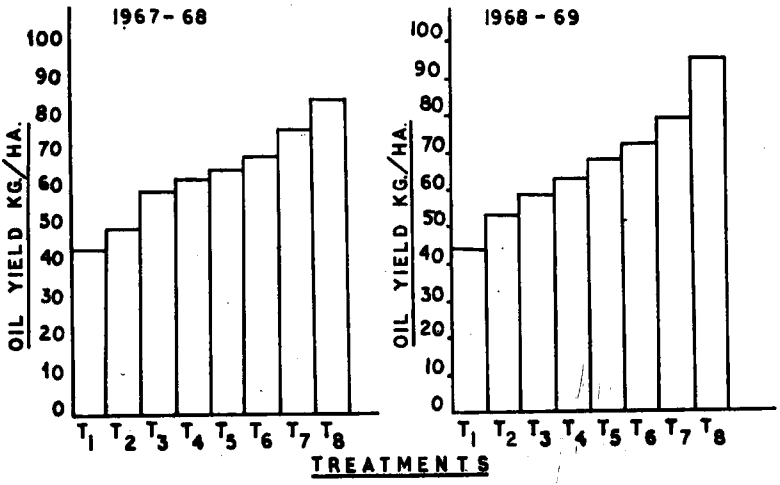

FIG.2. SHOWING TREATMENTWISE YIELD OF OIL PER HECTARE IN KG.

Perusal of Fig. 1 and Fig. 2 indicates that treatment having 175:105:105 NPK each gave herbage yield of 14,170 kg per hectare during 1967-68 and 15,920 kg per hectare during 1968-69 which gave 85.020 kg. and 95.520 kg. oil yield during both the years respectively which are almost double than control.

Conclusion

The experiment leads to the conclusion that *Ocimum kilimendscharicum* can be grown successfully in saline-alkali soils. For getting maximum yield of herbage, oil and camphor, fertilizer dose at the rate of 175:105:105 NPK each is recommended. Higher doses of fertilizer does not affect the quantity and quality of camphor and its oil at all. (Singh & Sharma 1970).

Acknowledgment

Authors are grateful to the Director, National Botanic Gardens, Lucknow, for providing necessary facilities for this work.

References

1. Abrol, I.P., Dargon, K.S. and Bhumla, D.R. (1973). Reclaiming alkali soils. Tech. Bull. 2. (Agri series) I.C.A.R., New Delhi.

2. Sharma, M.L., Pandey, M.B., Khanna, R.K. and Kapoor, L.D. (1972). Essential oil raised on alkaline soils. Indian Perfumer. Vol. XVI, Part II, p. 27-30.

3. Singh, L.B. and Sharma, M.L. (1970). Camphor from the oil of *Ocimum kilimendscharicum* raised on alkaline soils. Reichstoffe Aromen Octo. 1970. p. 389-90.

PACKAGE OF PRACTICES FOR ROSA DAMASCENA MILL

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ROSA DAMASCENA Mill, popularly known as Fasali gulab, is well known for its scented flowers which are used for extraction of rose oil and water[2]. In U.P. it is grown extensively in the districts of Aligarh, Barabanki, Ghazipur, Ballia and Lucknow. Besides the oil and rose water, rose attar and Gulkand is also prepared out of rose flowers. Every year[2-5] the demand of rose flowers is increasing and these products like oil, rose water, attar, gulkand have ready market and are utilized in the manufacture of soaps, cosmetics, perfumes, medicine, confectionery, perfumed tobacco, aerated water and syrups etc. As the demand for these products is ever increasing, the increase in area for cultivation shall be of great value. Rose growing[2] in India has been a very old art, but, however, growing of rose for profits need skill and lively horticultural practices. The practices which are helpful to farmers and have been based on experimental evidence at the Research Station, Banthra[1.5] are given below:-

Cultivation

Rosa damascena Mill prefers well drained soil with good humus content. *Rosa damascena* can withstand heavy soils. Experiments have shown that the plants can be grown up to pH 9.5 in Gangetic alluvial of North India.

Preparation of Land

During June-July two ploughings with soil turning plough are done. Green manuring by any legume crop is also done during rains and the field is made ready by October.

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* Paper read at the Symposium held on Development of Essential o[illegible] in U.P. at Kanpur during 17th, 18th January 1976 - organised by National Botanic Gardens, C.I.M.P.O., Lucknow, Azad Agriculture University, Director of Industries, U.P. and Ram Ganga Project, Kanpur.

After the field is ready, beds of convenient size are laid out, depending upon the source of irrigation.

Planting

Planting is done in rows. The best distance for planting has been found to be 1 m x 1 m apart. Pits of convenient size be made for planting the plants.

Cuttings

Cuttings obtained from shoots of spring season 10 to 30 cm long of 0.7 to 1.2 cm diameter (thickness), from 10 to 12 months old shoots are best. These should be buried half or three-fourth of their length in the soil for better success.

The best time of planting is October to November. If pruning is not required the plants can be planted up to middle of February.

One or two years old rooted cuttings (plants) are best for transplanting. Plants take two years for proper growth and by third year the flowers yields can be commercial.

Irrigation

The crop requires frequent irrigation. Special attention is to be given during the period for January to March which is the time for vegetative growth and flowering. In all 10-12 irrigations are required during the year. More irrigations are needed during vegetative period, i.e. during January-February. It is a common belief in the rose growing areas that more irrigation during flowering period may tend to lessen flowering and more vegetative growth.

Interculture

Interculture operations are very essential. The weeding should be done thoroughly. The earth around root zone of each plant should be stirred well. Frequent hoeings are carried before each and after each irrigations. Usually 2-3 weedings and hoeings are done during the month of January-February for good yields.

Pruning

In *Rosa damascena* pruning is very important operation. If pruning is not done and done later, the flower yield is greatly reduced. Special attention is, therefore, necessary for this operation. Normally the plants are ready after one year for pruning. Experiments were done on the time of pruning and the height of

pruning and it has been found that optimum time of pruning is from 1st to 15th January each year in North India. If pruning is done earlier, it has been observed that sprouting is less due to low temperature with more vegetation growth and less flowering. If the pruning is done after 15th of January, there is less vegetative growth and low yield of flowers.

Fertilizers

Application of fertilizers to *Rosa damascena* crop has been found to increase the flower yields. Experiments on application of fertilizers have led us to suggest the following schedule.

Nutrients	Dose	Time of application
Nitrogen (N)	200 kg. per hectare	Should be applied in two split doses, half 15 days after pruning and the rest half 30 days after pruning. May be applied through ammonium sulphate or di-ammonium phosphate
Phosphorus P_2O_5	50 kg. per hectare	Applied as band around the roots of the plants at depth of 3-5 cms just after pruning. May be applied through single superphosphate.
Potash K_2O_5	30 kg. per hectare	Applied in a bond around the plants top dressing just after pruning.

In addition, cowdung manure or F.Y.M. may be applied at the rate of 8 m. tons per hectare. An experiment on the light and heavy doses of nitrogen (20 to 160 kg of N per acre) was conducted. Nitrogen in the form of urea was applied at different dates after pruning by broadcast as well as in a ring around the plants. It was found that nitrogen application at the rate of 50 to 400 kg per hectare in the form of urea is beneficial for the production of flowers in *Rosa damascena*. Application of urea to the plants by broadcast is injurious above the dose of 50 kg nitrogen per hectare or 11.30 gm per bush. The yield of flowers obtained by the application of urea in a ring around the plants is definitely superior to the yield of flowers obtained by the broadcast of urea directly on the plants. It was seen that 200 kg per hectare nitrogen in the form of urea on 30th January, i.e., one month after pruning gave the highest yield of 1442.2 kg per hectare of flowers as against control (203.4 kg per hectare).

In another experiment nitrogen applied through calcium ammonium nitrate with a dose of 100 kg of nitrogen per hectare applied one month after pruning gave the highest yield of 1648 kg

per hectare as against control (578 kg/hectare).

Thus application of calcium ammonium nitrate appears to be most suitable in saline alkaline soils.

Flowering

In North India there are two flowering flushes. The main flowering period starts after 80-90 days of pruning, when done in the month of January, the flowering continues for about 40 days, the daily harvest of flowers increases in 1st 20 days - 25 days, and then it starts decreasing after reaching the optimum. When it starts falling, the flowers are obtained for another 20 days. The second flush of flowering is in the month of September-December.

It may be observed that cultivator should be very careful for collection of rose flowers during the period of flowering. He should harvest in early hours of the day and use them for distillation as soon as possible.

Disease and Pest

Rosa damascena is usually free from diseases. However, when pruning is done exposed stems often are attached by fungi and start drying. An application of Bordeaux mixture (2:2:50) just after pruning the plants have been found satisfactory for controlling the drying of twigs.

Yields

Average yield of flowers is about 2000 kg/hectare. However, it is greatly dependent upon the soil texture, pH, availability of nutrients and fertilizers supplied during the post-pruning period along with irrigation. The yield of 2nd flush during September each year is usually 1/10 or 1/15 of the main season yield.

On fresh weight basis .025 to .035% of rose oil is obtained, which is sold at the rate of Rs 25/- per gram.

Acknowledgment

Thanks are due to Dr. T.N. Khoshoo, Director, National Botanic Gardens, Lucknow, for his keen interest in the problem of rose cultivation and for giving the facilities to the authors.

References

1. Chandra, V. (1968): Rational utilization of user soils. unpublished paper read at Indian Science Congress.

2. Chandra, V. and Singh, A. (1970): Rose industry and suggestions for improvement. Indian Perfumer
3. Menon, A.K. (1960): Indian essential oils. A review. CSIR, New Delhi.
4. Singh, L.B. and Sharma, M.L. (1969): Rose oil flower of Rosa damascena Mill. raised on saline alkaline soils. Prof. Und. Kosmeltes. 384-386.
5. Singh, L.B. (1970): Utilization of saline-alkaline soils without reclamation. Rosa damascena, its botany, cultivation and utilization. Eco. Bot.
6. Srivastava, H.P. (1974): A note on the cultivation of Damasc rose on user soils. Paper read at get-together on the management and reclamation of user soils. At Research Station, Banthra, National Botanic Gardens, Lucknow.

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BREEDING OF OCIMUM SPECIES FOR NEW SOURCES OF ESSENTIAL OILS

S.N. Sobti and P. Pushpangadan
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Jammu-1

Introduction

Essential oils from species of Ocimum (Family: Labiatae) have been found to be useful in many industries like perfumery, cosmetics, flavouring etc. A programme of exploration, introduction and improvement of Ocimum species for their better utilization in the industry was taken up in the Regional Research Laboratory, Jammu. Extensive collection of germplasm was made and some new species also being discovered. One new species from Jammu was found to be of great importance in the programme of breeding Ocimum species for their oil rich in eugenol. The present paper gives the details of this species including the breeding works and the production of synthetic amphiploid species rich in eugenol and high oil yield.

Materials are from a wide collection of Ocimum species acquired by the authors from different parts of the world. Observations on morphological characters were made from living plants. Comparison of important morphological characters were made with the help of polygraph. The method adopted for cytological investigations are described elsewhere (Pushpangadan et al 1975). The percentage of oil was determined by hydrodistillation using a cleavanger apparatus. The oil percentage given is on moisture free basis. Major chemical constituents of the oils were determined by thin layer chromatography (TLC) using Benzene-Benzene + Ethyl acetate (98:2) as solvent systems. Vanalline in sulphuric acid was used as spraying agent for developing the plates. The standard isolates of various chemical constituents were used as reference.

Observations

Description of the new species of Ocimum

A new species of Ocimum which could not be matched with

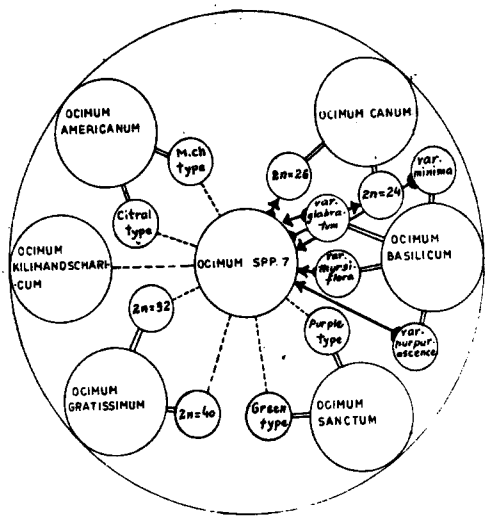

Fig. 1: Breeding relationship of Ocimum spps. No. 7 with the different varieties and types of 6 species of Ocimum. The dotted line indicates the failure of getting hybrids. The continuous line indicated the production of sterile hybrids. Arrow points to the female parent.

Fig. 2. A-C. Ocimum plants. A and C: O. canum and Ocimum spps. No. 7 and B: their F_1 hybrid.

any of the known species in India was found growing as a semi-wild plant near cultivated places or gardens in Jammu. Specimens of this species were sent to Calcutta herbarium and they identified the species as an *O. kilimand scharicum*. But a detailed taxonomical and cytological investigation of this species led us to conclude it as a new species. In the present paper this species is referred as Ocimum spp. No. 7.

Some of the important morphological characters of diagnostic value are presented in Table 1. Sixty chromosomes were counted from the mitotic cells analysed from both root tips and young growing tips. Meiosis was found to be normal except in about 7% PMCs showing certain abnormalities like formation of 3 or 4 laggards during anaphase I. Pollen fertility (on the basis of carmine staining technique) was found to be between 75 and 80 per cent.

A population of 100 plants was raised and the individual plants were separately distilled to see the variability in oil percentage and major chemical constituents of the oil. The oil yield varied from 1.0% to 2.5%. Major chemical constituents in all the plants were eugenol (50% to 70 per cent) followed by linalool (15 to 20 per cent), some unidentified esters (10 to 15 per cent), hydrocarbons (10 to 15 per cent). In all cases the oil obtained gave an undesirable fruity smell.

Breeding works

Hybridization experiments were carried out in this species mainly to remove the fruity smell of the oil and also to improve the eugenol per cent and total oil yield. Selections were made from the selfed line of high yielding and high eugenol content strains of Ocimum spp. s No. 7. A summary of the breeding results is graphically represented in Fig. 1. Hybrids were obtained in the following crosses: *O. canum* x *Ocimum* spp. No. 7, Ocimum spp. No. 7 x *O. basilicum* var. *minima, glabratum, thyrsiflora* and *purpurascence*. In all these cases there was no seed set when the reciprocal crosses were attempted. All the F_1 hybrids obtained were completely sterile. From the essential oil point of view of the F_1 hybrids of *O. canum* (2n = 24, Linalool type) x Ocimum spp. No. 7 was found to be very promising. Therefore, the details of only this particular hybrid are described in this paper.

Comparison of O. canum, Ocimum spp. No. 7 and their F_1 hybrids

A comparison of the important morphological characters of the F_1 hybrids (Figs. 2A-C) and their parents is presented in Table 1 and polygraphs (Figs. 3 A-E). From the table as well as from polygraphs it is clear that the F_1 hybrids are more vigorous in growth and showed heterosis for characters like height of the plant, length of inflorescence, length of corolla etc. Characters

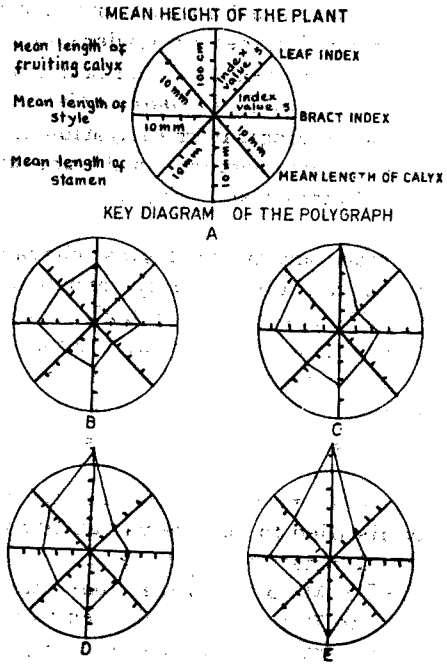

Fig.3. A-E. Polygraphs. A: key diagram of the polygraph, B: O. canum, C: Ocimum spps. No. 7 D: F_1 hybrid and E: Amphiploid.

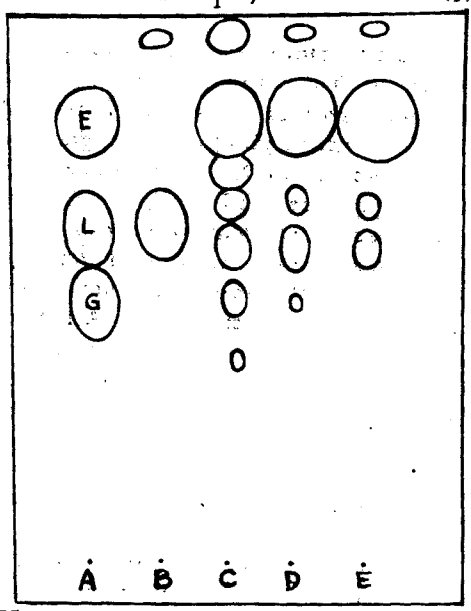

Fig.4. A-E. TLC separation of essential oils.
A: isolates - E = Eugenol, L = Linalool, G = Geraniol
B: O. canum, C: Ocimum spps. No. 7
D: F_1 hybrid and E: Amphiploid.

like size of leaves and bracts, length of stamen, style and fruiting calyx etc. were more or less intermediate between the two parents. The F_1 hybrids had more herbage yield. Like the female parent, *O. canum*, the oil yield was as high as 3% in the F_1 hybrid. However, the major oil constituent of the F_1 hybrid was eugenol like the male parent, Ocimum spp. 7. TLC separation of the major oil constituents of the F_1 hybrid and parents is presented in Fig. 4 (Figs. 4 A to D). It may be noticed from the figure (4D) that the unidentified esters was completely absent from the oil of the F_1 hybrid. The percentage of hydrocarbons was also less. The oil had a pleasant smell of eugenol.

The F_1 hybrid was completely sterile. Cytological investigations have shown that the mitotic cells contain 2n=42 chromosomes as expected. Meiosis was abnormal due to lack of chromosome pairing. There was no pollen fertility.

Induction of amphiploidy

Amphiploidy was induced in the sterile F_1 hybrids of *O. canum* (2n=24) x Ocium spps No. 7 (2n=60) by treating 0.3% colchicine in 10% glycerin on young inflorescence initiations and axillary buds. Fertile inflorescence were developed from some of these treated branches. The seeds collected were sown and the amphiploids were raised.

Amphiploids

The amphiploids resembled the F_1 hybrids for most of the morphological characters, but exhibited vigour in growth and had bigger leaves (Table 1 and polygraph Fig. 3E). Herbage yield was also more compared to the F_1 hybrids. The oil yield and percentage of eugenol in the oil showed variation in the 7 amphiploids raised. Three of them had about 3.0 to 3.5 per cent oil yield with about 60 to 75 per cent eugenol content (Fig. 4). The oil like the F_1 hybrid had a pleasant smell of eugenol.

Cytologically complete doubling of chromosomes was observed in the colchiploids. Meiosis was normal. Pollen fertility and seed setting was also normal, but the percentage of seed set was rather less when compared to the two parents. The three selected amphiploids were selfed as well as allowed to be cross-pollinated. The seeds collected from these inflorescences are to be sown in the next season for raising the progeny to study their behaviour and to make further selections.

Discussion

The new species of Ocimum discovered from Jammu could not be placed along with any species of Ocimum species reported

Table 1

Comparison of morphological characters of Ocimum canum, Ocimum spps. No. 7, their F_1 hybrids and amphiploids

Characters	O. canum	Ocimum spps. No. 7	F_1 hybrids	Amphiploids synthesized
Habit	Annual herb	Teriennial herb	Biennial or triennial under shrubs	Biennial or triennial under shrubs
Height (cm)	50 to 75 (66.5)	85 to 105 (98)	95 to 128 (115)	105 to 136 (170)
Size of leaf blade (cm)	3.2x1.3 to 4.5x1.8 (3.5 x 1.7) (=2.1)	2.6x1.5 to 5.5x3.5 (3.6 x 2.4) (=1.9)	3.0x1.9 to 4.2x2.1 (2.5 x 1.9) (=1.8)	4.2x2.5 to 5.5x3.0 (4.9 x 2.6) (=1.9)
Length of inflore-scence (cm)	15 to 28 (24)	15 to 25 (19)	33 to 47 (43)	24 to 30 (28)
Size of brcts (mm)	3.0x1.8 to 5.5x2.2 (5.3 to 2.0) (=2.7)	4.0x1.7 to 4.5x2.5 (4.2 x 1.9) (=2.2)	3.5x2.0 to 4.0x2.8 (3.6 x 2.4) (=1.4)	6.0x3.8 x 8.0x4.0 (6.8 x 3.9) (=1.8)
Length of Calyx(mm)	2.5 to 3.0 (2.7)	4.0 to 5.0 (4.3)	3.0 to 4.0 (3.7)	4.0 to 5.0 (4.5)
Length of Corolla (mm)	4.5 to 5.5 (5.1)	6.0 to 7.5 (6.5)	7.0 to 9.0 (8.3)	8.0 to 9.5 (8.5)
Length of Stamen (mm)	4.5 to 5.5 (4.8)	5.5 to 6.7 (5.9)	3.5 to 4.5 (4.3)	4.5 to 5.5 (5.0)
Length of style (mm)	6.5 to 7.0 (6.8)	7.0 to 8.0 (7.5)	6.9 to 7.0 (6.5)	6.5 to 8.5 (7.5)
Length of fruiting Calyx (mm)	4.5 to 6.0 (5.3)	6.5 to 7.5 (7.0)	3.5 to 4.0 (3.8)	6.0 to 8.0 (6.8)

( ) = Mean

(=) = Index = Length/Width

or known in India. The National Herbarium at Calcutta identified this species as *O. kilimandscharicum*, the camphor bearing exotic species of Ocimum introduced in India from Kenya. But our combined morphological, cytological and crossing experiments have provided definite evidence that this species is not *O. kilimandscharicum*. The only resemblance of this species to *O. kilimandscharicum* is its pubescent nature. Other morphological and floral characters especially those characters of diagnostic value to the species of Ocimum are quite different and distinct for this species. Chromosome number in *O. kilimandscharicum* is 2n=76 whereas in this species it is only 2n=60. Attempts to cross this species with *O. kilimandscharicum* have not been so far successful. In the light of these information it may be concluded that this species is an entirely new species and that it deserves a new species status.

Ocimum spp. No. 7 is interesting from the essential oil point of view. The oil distilled from this species had high eugenol content. But the oil yield as well as the herbage yield per plant was less. The oil has undesirable fruity smell. Hybridization experiments were carried out to evolve a new strain with desirable vegetative characters, oil quality and yield. From the results of hybridization with the six species of Ocimum and their different varieties and types, it was found that hybrids could be obtained only with the *O. canum* and *O. basillicum* varieties. With *O. canum* the seed set was obtained only when Ocimum spps. No. 7 was used as the male parent. Similarly, with all the four *O. basilicum* varieties seed set was obtained only when Ocimum spps. No. 7 was used as female parent. This is an example of what has been termed as unilateral incompatibility by Levin (1971).

From the essential oil point of view, the F_1 hybrids of *O. canum* (2n=24, linalool type) x Ocimum spps. No. 7 was found to be highly promising. The F_1 hybrids for most of their morphological character are intermediate between the two parents and have a pleasant smell of eugenol without fruity smell. The TLC analysis of the oil has shown that it contain about 65 to 70% eugenol. Linalool, the major oil constituent of the female parent *O. canum* was only 15 to 20 per cent in the F_1 hybrid. The biogenetic pathways proposed for phenologic and terpenoids are quite different (Neish, 1960, Murray and Lincoln, 1972; Pushpangadan et al, 1975). The F_1 hybrids also had the minor constituents linalyl acetate, hydrocarbons and geraniol like the male parent Ocimum spps. No. 7. But interestingly the unidentified ester found in the oil of Ocimum spps. No. 7 was completely absent from the oil of the F_1 hybrid which had no fruity smell.

The F_1 hybrid was completely sterile, but fertility was restored through colchicine treatment. The amphiploids raised were similar to the F_1 hybrids for most of their morphological

characters except that they were more vigorous in growth and had high herbage yield. However, the progenies of amphiploids showed some variation with regards to the oil yield and eugenol content. Some of them had good herbage and high oil yield. Of these, two plants have high eugenol content higher than the Ocimum spps. No. 7. Seeds have been collected from the selected amphiploids. It is expected that the final selection from the progenies of the next one or two generations will have uniformity with respect to eugenol percentage in the oil as well as in oil yield.

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References

1. Levin, A. D. (1971). The origin of reproductive isolating mechanisms in flowering plants. Taxon 20: 91-113.

2. Murray, M. J. and Lincoln, D. E. (1972). Oil composition of Mentha aquatica, M. longifolia F_1 hybrid and M. dumetorum. Euphytica 21: 337-343.

3. Neish, A. C. (1960). Biogenetic pathways of aromatic compounds. In Ann. Rev. of Pl. Phyiol. 4. (Annual Review. Inc., USA).

4. Pushpangadan, P., S. N. Sobti and Reat Khan (1975). Inheritance of Major Essential Oil constituents in Ocimum basilicum var. glabratum Benth. (French Basil). Indian J. Exp. Biol. 13: 520-521.

5. Pushpangadan, P., S. N. Sobti and Reayat Khan (1975/76). Karyomorphological studies in the genus Ocimum I. Basilicum group 'the nucleus' 18: 177-182.

CULTIVATION OF *MENTHA*

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Mentha is a source of peppermint (Menthol) which is obtained from its oil. Peppermint is used in many medicines, pan, pan mashala, sweets, dental preparation etc. Before few years its entire demand was met by import from foreign countries. Since few years its production has started in our own country and we have reached to the stage of exporting the menthol. For the progress of this industry the expansion of cultivation of mentha is essential.

There are a number of species of mentha but peppermint is produced from its Japanese variety known as *Mentha arvensis* Linn. botanically. For the first time its cultivation was started in India through Drug Research Laboratory, Jammu and Kashmir. Now it is cultivated in U. P., Panjab, Jammu and Kashmir and some parts of South India.

For the cultivation of mentha its suckers (Roots) are used as planting material. After the preparation of land the suckers are planted in rows. For a hactare of land 300-350 kgs suckers are sufficient.

Land and its preparation

For mentha, loam and sandy soil is most suitable. The land should be well levelled and there should be good drainage of water. The land should be watered before preparation. When it becomes suitable for ploughing, it should be ploughed 2 or 3 times with the help of tractor or simple plough. After every ploughing planking should be done so that the clods may not form in the field and the moisture in the soil may be retained.

Manuring

While preparing the land the field should be manured before last ploughing. While mixing the fertilizer, there should not be much moisture in the field. Five quintal of neem, groundnut or castor cake, 125 Kgs ammonium sulphate, 60 Kgs. super phosphate and 25 Kgs. B.H.C. 10% should be mixed with the soil. After this,last ploughing should be done.

Sowing time

The planting time of the mentha suckers is from 15th January to 15th February. The sowing is done up to 15th of March in certain areas.

Methods of sowing

For sowing, the suckers should be healthy and disease-free. In the field 1.5-2.0 cm deep furrows should be made from east to west at the distance of 45 cm from each other. These furrows can be made with the help of tractor or hand cultivator. It is less time consuming and less expensive than other methods. Suckers are put in the furrows end to end. After this,these are covered with soil. Irrigation channels or plots should be made according to the need. After 24 hours of planting the field should be irrigated.

Irrigation

After the sowing of the suckers the field should be given light irrigation and then according to need the field should be irrigated at an interval of every 8 to 10 days.

Hoeing and weeding

Germination in the field starts after 15 days of the plantation. After the sprouting of the plants if some weeds are seen, these should be removed at once. Weeds are very harmful for the crop. For this hoeing and weeding should be done from time to time. When the plants take the length of 10-15 cm, the hoeing should be done with the help of kudali.

Spraying of fertilizer

When the plants grow 20-25 cm high, 2 per cent urea in water should be sprayed over leaves with the help of sprayer. By spraying fertilizer every 4th week the plants take a nice growth and the leaves also grow in size. After the second cutting spraying of the fertilizer should be continued after every second week.

Harvesting

After 100-105 days of the sowing of the Mentha flower buds start appearing on the plants. This indicates that the crop is ready for harvesting. The plants should be cut from 8-10 cm above the ground. Generally three cuttings of Mentha are obtained, first cutting from 15th May to 31st May, second in mid-July about 60-70 days after the first cutting and third cutting in October.

After third cutting it becomes cold due to winter and the further growth of the plants almost gets stopped.

Drying

When the material is to be distilled in small units (water steam distillation unit) it is most economical to use dried material. For drying the crop of Mentha should be tied in small bundles and spread in shade. The bundles should not be very thick, otherwise there is a fear of the fungus growth in it. The crop of Mentha should not contain much of the other grasses or weeds.

Distillation

The mentha oil is obtained by the steam distillation. Mentha is chopped and filled in the stills or tanks of the distillation unit. Steam is given from below. It takes up the oil from the grass. On condensation the vapours get cooled. The oil separates and floats on the surface of the water. The water is separated and oil is taken out. On the fresh weight basis of the green plant material 0.5% yield of the oil is obtained.

Diseases

Mentha suckers from the following diseases generated by insect and fungus.

(1) Wilting: In this disease the colour of the stem of the plant gets black and the leaves turn yellow. To remove this there must be good drainage of water and fungicides such Diathane 78% should be sprayed.

(2) Jala: In this disease the leaves get adhered mutually and web is formed between them. The plant suffering with disease should be removed from the field.

(3) Rust: In this disease the chlorophil below the leaves gets exhausted and the leaves start falling within 24 hours. In this disease Diathane 78% should be sprayed.

(4) White ants and leaf borer insects: These insects bore into the suckers and leaves. Stems and roots get hallow. To protect the crop from the insects 20% Endrine and 10% B.H.C. should be sprayed in the field.

JAPANESE MINT IN THE TERAI BELT OF UTTAR PRADESH: CULTIVATION STATUS AND PROBLEMS

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The cultivation of *M. arvensis* in the Terai region is largely confined to the districts of Rampur and Moradabad. Rampur district comprising Rampur Tehsil, Bilaspur and Suar account for about 1200 to 1400 hectares, while Moradabad district comprising Tehsil Sadar, Sambhal and Amroha have an area of about 600 to 800 hectares. By and large the cultivators prefer to have small acreages of the crops (1 to 2 hectares) and few cultivators have larger holdings (3 to 5 hectares).

Cultivation Practices

The cultivation practices as followed by the best growers in the region are summarised below:

At the time of land preparation about 20 to 25 cartloads of F.Y.M. or 40 cartloads of sewage sludge (Amroha area) per hectare is applied and the land thoroughly prepared. Planting starts towards the later half of January and is completed by early February, while seedlings are transplated after taking a crop of wheat till early May. The row to row spacing is maintained between 30 to 45 cm. The seed rate being 400 kg/ha. The practice of fertilizer application varies in the different parts of the belt, 1/2 to 2 bags of DAP is used as a basal dose, followed by application of urea (1 to 2 bags/ha) in split doses - usually in 3 to 6 splits before taking the first crop cutting by 15th May. In the Sambhal area horn meal is applied at the rate of 3 to 4 q/ha. and some cultivators of the area apply heavy doses of organic manure to the potato crop and in rotation grow mentha, using little additional nitrogen.

Intensive care of the crop is taken, the weeding is very thorough and frequent, the author learnt during the course of a tour during May through the Mentha growing belt of U.P. that the crop had been weeded at least 3 to 4 times and if need be one

additional weeding would be given before the harvest of the crop towards the end of May or June. The effort of the cultivator is towards keeping the land free of weeds, and this practice by and large contributes most to the success of the crop in the region.

The crop is irrigated very frequently, a large majority of the cultivators reported having irrigated the crop about 13-14 times till mid May.

The common rotation being followed are:

(1) Mentha - potato - Mentha
(2) Mentha - wheat - Transplanted Mentha
(3) Mentha in between rows of Rabi season vegetables

Yield of oil

The maximum oil yield is obtained in the first cutting, in the second cutting the yield is low, while in the third cutting the yield obtained is very poor. Majority of the cultivators take only two cuttings and plough up the crop in October and grow wheat, potatoes or other seasonal vegetables. No precise estimate of the fresh herb yield could be obtained, cultivators reported yields in terms of 1 to 3 truckloads from their holdings.

	Average oil yield		High *Yield of oil*
1st cutting	35 to 55 kg/ha	]	
2nd cutting	25 to 35 kg/ha	]	100 to 150 kg/ha.
3rd cutting	12 to 18 kg/ha	]	

The transplanted crop after wheat yields about 50 kg. of oil/hectare from two cuttings. A cultivator with a total holding of three acres grew mentha in half an acre, and reported having obtained 35 kg. of oil from the area on an average over a period of five years.

Distillation

Distillation facilities are abundant due to the enterprise of the individuals. In the Terai belt there are about a dozen distillation units which cater to the needs of the growers, and many more are being set up.

Thus the success achieved in the cultivation of *M. arvensis* in the Terai belt is due to the intensive care the crop receives at the hands of the growers, the adequate distillation facilities provided by private enterprise and the trained workers being on the move during the growing season.

Mentha arvensis is a one year crop in the Terai belt, as the cultivators feel that the second year crop cannot be a success due to the very heavy weed infestation. The price fluctuation of oil is a great damper for further extension of the crop in the region. With the prices of inputs-pertilizers, labour costs, etc. going up and the intensive efforts and labour put in, the grower feels that the minimum price of oil should be between Rs. 140/- to Rs. 170/- per kg. so that they get a fair return on their investment and labour.

The investment of some of the best growers of the region varies from Rs. 6,000/- to Rs. 8,000/- per hectare. The question arises as to how many of the growers can invest so much money in cash and kind and for how long under an uncertain price policy.

If the private enterprise is to develop, or even if the existing area of the crop is to be maintained in the Terai belt which can be rightly called as the prosperous homeland of *Mentha* crop in India, the improvement of the crop itself is also a fundamental necessity. The active assistance from Richardson Hindustan Limited and others along with help from Government agencies seems justified in national interest. The organisation and finance of agricultural and technological research should not be overlooked.

The development of the menthol industry in the Terai belt has been phenomenally rapid in a short span of time, steps should be taken to maintain it and fill the missing links.

The signs of a live industry are that it should have business syndicates, technologists associations and journals to serve as a forum for discussing the problems facing it from time to time.

Every industry has its waste product and it should be the aim of scientific workers attached to such industry to exploit the potentialities contained in the waste product to the best advantage. This industry has the waste product viz. marc which can be economically and profitably utilized to serve mankind.

Under all constraints and limitations it can be truly said that the farmer has done his very best for the crop in the terai belt and it is necessary for the distillers of the crop to consolidate the gains of ready availability of the raw material by giving out a very fair and reasonable price of oil, well before time.

UTILIZATION OF USAR LAND FOR THE CULTIVATION OF ESSENTIAL OIL BEARING PLANTS

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The problem of utilization of Usar Land has been drawing the attention of scientists and agriculturists, for quite a few decades. In the past, during the period 1925-30, Dr. N.R. Dhar of Allahabad suggested the use of molasses for the reclamation of Usar Lands. However, considering the present day cost and the scarcity of molasses, the use of molasses is no more a practical proposition. Some time back there has also been a suggestion that 'Babul' and other alkali resistant plants should be raised on Usar Lands for changing the nature of the soils. Such a process of reclamation would however, always take long periods of growth of the plantations, say over 25 years, and so this process of reclamation could never be of any interest to us, in an era of fast changing economy and rapidly deteriorating situation, because of increased pressure on cultivable land, which in turn is due to increased population and other causes. More recently, the methods suggested are that of adding ammendments such as gypsom, lime, pyrites, sulphuric acid, etc., coupled to a few manipulative techniques. And thus, from time to time different proposals have come before us, and our hopes get raised to dizzy heights and an atmosphere gets created of a feeling, that Usar Lands are going to be reclaimed, and success, it seems, is just round the corner!!! If we consider that we began to think about the problem of reclamation of Usar Lands, some time say in 1925-26, then, after about 35 long years, Dr. Kaul in his most informative booklet titled 'Conquest of Usar Lands', brings to our notice that in 1961 in U.P. alone, we had as large an area as 30 lakh acres of Usar Lands, and another 50 lakh acres of eroded land, lying un-utilized, because of its non-suitability for the growth of plants. After 1961. now in 1976 another fifteen years have passed, and in spite of our 'interest' in the reclamation of Usar Lands, the recent published statistics do not give any indicated that any substantial acreage of the above mentioned Usar Lands have been reclaimed, or that, such reclaimed Usar Lands have made, any worth-the-name contribution to the production of agricultural crops or industrial crops. This means that

from 1925 to 1976 a period of 51 years has passed and we are still where we were half a century ago! During this period the population has increased and the pressure on land for the production of food crops has increased beyond all imagination. In recent years, many times, we had to spend considerable part of our valuable foreign exchange earnings, on the IMPORT of FOOD.

The situation thus is that land already under food crops cannot be diverted to the cultivation of essential oil bearings plants. And, so far, all our efforts of bringing Usar Lands under cultivation have proved miserably slow and disappointing, and the 'common farmer' is not in a mood to come forward to take interest in bringing the Usar Land under his plough. People running the essential oil industry need land very urgently for the cultivation of essential oil bearing plants in the country, and for exploiting fully the export potential.

2. Let us review why we have not been successful in reclaiming Usar Lands in substantial acreage, during the last almost half a century. The author feels that the reasons are:

(i) We have not taken a realistic stock of all the problems involved in the reclamation of Usar Lands, and all our efforts in that direction have been half-hearted.

(ii) We have grossly under-estimated the costs, involved in the reclamation of Usar Lands, with the result that we did make a few starts here and there for the reclamation of Usar Lands, and it was always with inadequate funds. The schemes were pursued half-heartedly under financial strains, and ultimately the schemes were left half done, dis-illusioned and dis-heartened without even caring to lay bare the causes of failures. The on-lookers were completely discouraged, even though they had some interest in the reclamation work, in the beginning. So, now 'the farmers' are not coming forward, even when land is offered free to them. If here and there a few farmers have come forward, it is with some entirely different interest other than the cultivation of crops on Usar Lands.

(iii) It has neven been quite clear to us, as to which of the costs of reclamation are to be borne by Government, and which costs are necessarily to be borne by the farmers, in the best interest of economy and faster progress.

(iv) It has never been appreciated fully that,taken as a whole, the problems of reclamation of Usar Lands are beyond the comprehension of the 'common farmers', both technologically and financially. Financial problems apart, if the common farmer is to rely on 'advice' from different quarters for his success, the situation is, that more-often-than-not, the advice he gets is not complete in many respects, the advice does not reach him at the right time, and

the farmer does not have the means and time, to run from door to door, collecting the advice, and sorting out which part of the advice is best suited to his particular needs.

(v) The problem of reclamation and utilization of Usar Lands could certainly be handled better, and with much greater chances of success, by 'technically qualified' persons/entrepreneurs, than by the 'common farmers'. However, roping-in the technically qualified persons/entrepreneurs for this work presents another set of problems and considerations, to which unfortunately no attention has been paid by us so far. The technically qualified persons/entrepreneurs are far better placed in matters of running from door to door for pooling up the necessary finances, for collecting the necessary information from various quarters, and for applying their own mind and experience, for achieving success in the reclamation and utilization of Usar Lands.

Each of the above mentioned five points needs further elaboration. However, the author will be able to cover only some of the aspects of the problems in this brief paper.

3. A very valuable work has been done by the Department of Agriculture, U.P. at the Agricultural College, Kanpur, by publishing the book titled "Nature of soils of large Usar Blocks of Kanpur District" (1975). The book gives exhaustive information for each of the usar patches of land, measuring over 200 acres. For each of the blocks, the book gives information covering the nature of the soils, the existing vegetation on the land, and the distance of each of the blocks from the nearest important landmark. This is the first most important useful step in the right direction. Such information should be published for all the districts of U.P. and will prove very useful for any one, who is interested in the reclamation and utilization of Usar Lands of U.P.

Another very important work has been done by CIMPO and NBG, by publishing useful information about the possibilities of cultivation of many essential oil bearing plants and medicinal plants, and would prove very useful as and when Usar Land is reclaimed and brought under cultivation.

4. Since cost of reclamation is the most important factor, let us now examine, what exactly are the different heads under which we will have to incur expenses during the process of reclamation of Usar Lands:

(i) Irrigation facilities are a MUST in any programme of reclamation of Usar Lands. Canal irrigation has its own problems, and tube-well irrigation presents another set of difficulties. The basic thing is that water must be available in adequate quantities and at the right time, for reclaiming Usar Lands. Expenses under this head will vary from patch to patch and will have to be estimated correctly.

(ii) Electric power is preferable, but if it is not available at least diesel power will have to be provided for irrigation and other mechanical operations, to be carried out on the Usar Lands under reclamation, and after successful reclamation, power will be necessary for the economical agricultural production.

(iii) Approach roads will have to be provided upto the Usar Block under reclamation. In any reclamation programme lot of material by way of ammendments, fertilizers, and other utilities will have to be moved to the Usar patch/Block and after reclamation the agricultural produce will have to be moved from the relaimed land to the markets, speedily and economically. If proper approach roads are not provided, the reclamation operation is going to prove time consuming and uneconomical, and would prove discouraging to the farmer, interested in the reclamation of Usar Lands.

(iv) The cost of breaking the hard-pans in the Usar patch and other costs of preparation for land reclamation, have to be estimated correctly, if the farmer is to be saved from disappointments.

(v) The cost of ammendments such as, gypsum, lime, pyrites, sulphuric acid etc., has to be estimated in a businesslike manner. Under-estimation of costs will do more harm than over-estimation.

(vi) Even after the alkalinity or salinity of the land has been removed, the land cannot become useful unless suitable quantity and suitable quality of fertilizers is added to the reclaimed land. The cost has to be estimated correctly.

(vii) After the introduction of canal irrigation in certain areas, there have been instances where new patches of Usar Land have developed. Poor drainage of land is a curse, and this aspect of the problem has to be tackled properly and permanently. The cost of drainage must be estimated correctly.

(viii) A deep-water-table on the Usar Lands may not prove a nasty problem in the reclamation programme. On the other hand a high-water-table is likely to be a permanent nuisance in the case of most of the crops. Adequate drainage arrangements so as to lower the water table is an important consideration. Cost of drainage arrangements must be estimated correctly.

(ix) Apart from the necessity of adding fertilizers in the reclaimed lands, as mentioned in item six above, an adequate level of HUMUS will have to be developed in every reclaimed land, for developing proper conditions for the healthy plant growth, if full benefits of all the in-puts are to be reaped.

(x) It will be necessary to keep a close watch on the reclaimed land for attaining proper level of trace elements so as to attain a health growth of crops on the land.

(xi) Improvement of soil texture by the addition of sand or other ammendments will have to be given proper consideration.

(xii) The cost of running from door to door for seeking advice in matters of soil analysis, fertilizers, weedicides, pesticides etc., must not be ignored, because even after these Herculian efforts, if the reclaimed land does not give bumper production, no purpose will be served. This may not be all. The author feels that some scientists and agriculturists might like to add a few more items of expenses involved in the reclamation of Usar Lands, such as soil inoculation, so as to obtain the maximum possible production from the reclaimed lands. The costs of reclamation under all these twelve or more heads must be estimated correctly for the particular patch of land, and, only by taking into account, all these items of expenses, we will arrive at the REAL cost of reclamation of Usar Lands, and then only we will be able to avoid disappointments, which we have had so far.

6. The author would like to stress that, as it is, the average per acre production in India is probably the lowest in the world. It may be that for various reasons, it may not be possible for all concerned to coax 'the Common farmers' to increase their per acre production on their lands which they own. But in a new programme such as the reclamation of Usar Lands, let us set up high production targets by a policy of 'High in-puts, High out-puts'. It is not enough that the earstwhile 'white' coloured Usar Land is changed into a land with just a 'green tinge'!!!, by make-shift arrangements. We must convert the Usar Land into a first class bumper crop producing region, by doing every thing which gets suggested by the twelve or more items of expenses suggested in para 5 of this brief paper.

7. If we really wish to reclaim the 30 lakh Usar Land and another 50 lakh acres of eroded land, in any measurable time, we will have to shed-off all our notions of being able to reclaim Usar Lands within a cost budget of Rs.600/800 per acre, and instead, we should prepare ourselves to face the reality, that, at the present level of costs all round, the REAL cost of reclamation is going to be around Rs.3000/4000 per acre, when the reclamation is done without permanent drainage arrangements on the reclaimed land. Whenever possible, the reclamation of Usar Land must be done only by adopting 'tile drainage' which is the ultimate, permanent solution for fighting successfully the problems arising out of water soluble salts, which is the main problem of the Usar regions. The cost of reclamation with tile drainage will be Rs.7000/8000 per acre.

8. It will be preposterious on the part of the author to assume that none of the scientists/agriculture experts ever thought on these

lines: nay, many of them must have already arrived at these very conclusions, by logical deductions. Just multiply Rs.6000, the average cost per acre, by 30 lakhs and/or 50 lakhs, and the figures of total investments become an astronomical figure. They must have felt shy of facing these figures and so they tried to circumvent by slip-shod suggestions, and, those suggestions have not worked. The author feels that by a policy of 'BOLD' steps of, incentives, tax concessions, allotment of economic holdings, and other steps leading to a 'self-generating-economy', the finance for this huge project could be eked out-of-the 'sweat and toil' of enthusiastic technically qualified entrepreneurs, who are waiting at the cross roads for finding outlets of their talents. Yes, there is a way out.

9. For building up our courage to take up such a project of reclamation of Usar Lands, which requires huge finances and Herculian efforts, we must take notice of the fact that U.S.A. and U.S.S.R., who apparently have plenty of agricultural land, and much less population to be supported from the produce of land, find it 'advisable and economical' to reclaim their Usar Lands. Holland and Denmark consider it 'profitable' to push back the SEA, by several miles, and snatch the land from the sea, and work constantly to fight against the problems arising out of low-level, saline lands. Italy finds it worthwhile to reclaim its marshy lands. Why not we?

10. If we do not make up our mind to spend our ingenuity, time, money and efforts on the reclamation of our Usar Lands, in due course, we will have to pay continuously by the nose huge sums on the import of FOODS.

11. The essential oil industry, with its high priced end-products, given proper incentives, would probably be the first people to come forward to put in all their might in the direction of reclamation and utilization of Usar Lands. They do need urgently, land for the cultivation of essential oil bearing plants. Not only they would convert the Usar Lands into first class fertile lands, but they would earn foreign exchange too.

12. With all these excellent prospects ahead, let us take a serious second look at the problem of utilization of Usar Lands, for the production of agricultural crops in general and essential oil bearing plants and medicinal plants in particular, in minimum time: the problem is most urgent.

(Paper read at the "Symposium on Development of Essential Oils in Uttar Pradesh", held under the "Ramganga Development Project", at H.B.T.I., Kanpur on January 17 and 18, 1976).

CULTIVATION OF SCENTED JASMINES ON SALINE-ALKALI SOILS

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The genera Jasminum (Fam. Oleaceae) supply the most iost important and indispensable flower perfumes which are truly natural and unimitable. About 43 species of Jasmines are found in India. But all are not scented.

India has about 15 million acres of land which is unproductive due to high salt concentration and high alkali reaction (Anonymous, 1965). Such area is increasing day by day. If these soils could be utilized successfully for the cultivation of scented jasmines, which are aromatic/essential oil bearing plants, these waste lands (saline-alkali) can be put to use and would thus help country's economy by way of either import substitution or export promotion. Alkali and saline soils are to be managed in such a way that a good economic return may be obtained.

With a view to screen out plants capable of growing on alkaline soils, some scented species/varieties of jasmines were raised at Research Station, Banthra of National Botanic Gardens, Lucknow, where soils have a pH of 8 to 10 and are alkaline in reaction. The names of the jasmine plants which were tried are given below:-

1.	*Jasminum grandiflorum*	-	Chameli
2.	*J. multiflorum*		
3.	*J. auriculatum*	-	Juhi
4.	*J. flexile*	-	Malati
5.	*J. humile*		
6.	*J. laurifolium*		
7.	*J. primulianum*		
8.	*J. arborescens*	-	Muta Bela
9.	*J. sambac*	-	Madanman
10.	*J. sambac*	-	moghra

11.	*J. sambac*	- motia
12.	*J. sambac*	- kashmiri moghra
13.	*J. sambac*	- palampur
14.	*J. pubescens*	- kund

Among the above jasmines the following species/varieties came up successfully and attained a nice growth on the alkaline soils at Research Station Banthra:-

1.	*J. grandiflorum*	- Chameli
2.	*J. sambac*	- Moghra
3.	*J. sambac*	- Motia
4.	*J. sambac*	- Palampur
5.	*J. sambac*	- Kashmiri Moghra

Their performance under alkaline conditions is summarized as below:

Jasminum grandiflorum:- At Research Station Banthra, the plants of Chameli were planted in August 1967 and they started flowering in October 1969, i.e. about 2 years after planting. In North India the flowering time is September to December, while from Coimbatore it has been reported that Chameli flowers almost throughout the year with profuse blooming from April to November. The plants are highly spreading in nature, and therefore a spacing of 1.5 m to 2 m either way is required. In the first year of plantation, the average yield was 250 kg flowers per ha., but in the successive years, the average yield rose to 360 kg per ha.

Pruning trials on the plants showed that, light pruning restricted only to remove dried, diseased branches and excessive foliage in the month of January, i.e. just after flowering time, improved the yield of the flowers. In this case, when this type of light pruning was done, the average yield of flowers obtained was 360 kg per ha. as compared to unpruned plants, in which average yield obtained was 250 kg per ha. An average yield of 370 kg per ha. to 637 kg per ha. is reported from the Chameli fields, where the soil is normal, in the commercial plantations located in the districts of Ghazipur, Ballia, Farrukhabad and Jaunpur. Chameli flowers are very light and one kg flowers obtained from the plantations of Research Station Banthra, number 12,000 to 14,000.

Fresh flowers from the above plantations were extracted with n-hexane purified to perfumery grade. On distilling of the solvent, 0.25% concrete on the weight basis of fresh flowers was obtained. The concrete was a semi-solid, waxy, yellowish-brown in colour and having characteristic odour of fresh flowers of Chameli. The concrete on extraction with dehydrated alcohol

gave 54% alcohol soluble absolute possessing true odour of Chameli flowers. This plant is very successful to be grown in the Indo-Gangetic plains of North India. Its plantations last for 10 to 15 years. The plantations as old as 50 years have also been reported. They are propagated through layers. Layers become ready within 2 months, for planting. Layering time is July-August, in North India.

As the flowers are sold at the rate of Rs 6/- per kg, a gross income of Rs 2160/- per ha may be obtained by a cultivator, or 900 g of concrete valuing Rs 3600/- may be obtained from one ha of plantation. The cost of concrete being Rs 4000/- per kg.

Jasminum sambac - Moghra:- It is one of the jasmines which is hardier than Chameli for Usar soils. Its fragrant flowers are used in perfumery, garlands, chaplets decoration bunches and for religious offering. It is a bush type plant with an average height of about 75 cm to 1 m and 50 cm to 70 cm spread. They are generally planted with a spacing of 1 m both ways. The flowers are creamy white, fragrant and the flowering time is from May to July. Though its vegetative growth is very good in alkaline soils of Research Station Banthra, but it did not prove a heavy yielder of flowers under alkaline conditions. Only 300 kg of flowers per ha could be obtained on the average. Its plants are usually propagated by layering during the month of July-August in North India.

Fresh flowers from the plantations at Research Station Banthra were extracted with n-hexane purified to perfumery grade. On distilling off the solvent 0.21% concrete on the weight basis was obtained.

Jasminum sambac - Motia:- Its flowers are white, fragrant and resemble that of Moghra. Motia could also be successfully grown on the alkaline soils of Research Station Banthra. Its flowers are used in perfumery, garlands, chaplets, decoration bunches and for religious offerings. It is a bush type plant with an average height of 75 cm to 1 m and spread of 50 cm to 75 cm. The white fragrant flowers remain in bloom from May to July. Although its vegetative growth is very good under alkaline conditions of Research Station Banthra, but it did not prove to be a good yielder. Only 300 kg of flowers per ha could be obtained on an average. Its plants are usually propagated by layering during the month of July-August in North India.

Fresh flowers from the plantations at Research Station Banthra were extracted with normal hexane purified to perfumery grade. On distilling off solvent 0.22% concrete on the weight basis was obtained.

Jasminum sambac - Palampur:- This cultivar of jasmine proved to be most successful on usar soils of Research Station Banthra. The plants on an average grows to a height of 1 m to 1.25 m and spread of 75 cm to 1 m at the Research Station. Its flowering period spreads from April to June, though scanty flowering continues up to August. The creamy white fragrant flowers are used in perfumery, garlands, chaplets, decoration bunches and for religious offerings.

It proved to be a high yielder and on the average 2000 to 2500 kg of flowers could be obtained in one ha of plantation. The flowers are too light as 25000 to 35000 flowers weigh one kg. They are usually propagated by layering during the month of July-August. Fresh flowers from the plantations at Research Station Banthra were extracted with normal hexane purified to perfumery grade. On distilling off solvent 0.19% concrete on the weight basis was obtained.

As the flowers are sold at the rate of Rs 6/- per kg, a gross income of Rs 12000 to 15000 may be obtained from one hectare of plantation. On extraction with solvent 3.800 kg to 4.750 kg of concrete valuing Rs 15200 to Rs 19000 (at the rate of Rs 4000/- per kg) may be obtained from one ha of plantation of this variety of jasmine.

Jasminum sambac - Kashmiri Moghra:- Of all the sambac cultivars introduced at Research Station Banthra in the alkaline soils, the flowers of Kashmiri Moghra are more fragrant, heavier and bold. Eight hundred fifty to 1050 flowers weigh one kg. The plants on the average grow to a height of 75 cm to 1 m and spread of 75 cm. It also proved to be a high yielder under alkaline conditions and on the average about 1500 to 2000 kg of flowers could be obtained in one ha of plantation. The plants are shy bearer for the first three years but from 4th year onwards they give optimum yield. These are usually propagated by layerings during the month of July-August.

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References

1. Anonymous (1965): Report on the study of waste lands including saline alkaline and water logged lands and their reclamation. Committee on natural resources, Planning Commission, New Delhi.
2. Srivastava, H. P. and Sharma, M. L. (1974): Cultivation of Jasminum grandiflorum L. on Saline Alkaline Soils. Ind. Perfumer 17(1): 25-26.

STUDIES ON ESSENTIAL OIL OF ZINGIBER CASSUMUNER ROXB.

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Zingiber cassumuner[1] Roxb. (family: Zingiberaceae) known as 'Banda' in Hindi, is distributed throughout India, Ceylon, Malaya and is cultivated in tropical Asia.

Zingiber cassumuner has medicinal reputation as aromatic tonic and externally applied to boils and enlarged glands. In China and Malaya it is used as a condiment and in domestic medicine. Thin dry slices of the root are sold as a well known vermifuge.

As no work seems to have been done, it was thought worthwhile to study the chemical composition of the essential oil.

The crushed rhizomes when subjected to hydro distillation yielded camphoraceous essential oil (1.4%). On examination by gas-liquid chromatography, infra-red spectroscopy and classical chemistry, the composition of the oil was: α-pinene (7.26%), d-camphene (3.40%), β-pinene (3.36%), zingiberene (11.28%), ar-curcumens (5.05%), camphor (4.42%), linalool (4.29%), α-terpineol (32.86%), d-borneol (13.00%) and zingiberol (11.11%) along with traces of isoborneol. The preliminary investigations[2] suggested that the oil possesses antifungal activity against Tricophyton mentagrophytes, Curvularia oryzae, Helminthosporium sp. and Mucor racemosum etc. (in vitro).

Experimental

The rhizomes of Zingiber cassumuner Roxb. were procured from Calcutta. The pale yellow oil with camphoraceous odour analysed for: Specific gravity (28°) - 0.9120; Refractive index (28°) - 1.4896; Acid value - 3.60; Ester value - 23.60; and Ester value after acetylation - 92.46.

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The gas liquid chromatogram of the oil was recorded on Aerograph 51 instrument using polyester (20% DEGS on chromosorb) column.

Column Chromatography of the Oil

The essential oil (32.1 g) was chromatographed over alumina eluted successively with light petroleum (40-60°), benzene, either and ethyl acetage. The eluants were collected in 50 ml. fractions and subjected to TLC. The spots were detected by exposing the plate to iodine vapours. Fractions with identical Rf values were mixed together (Table 1) and studied for their constituents.

Table 1

Fraction No.	Eluant	Volume used (litres)	Weight of the fraction (g)	No. of spots on TLC
A	Light petroleum (40-60°)	2.5	4.25	Three
B	Light petroleum (40-60°)	3.0	5.14	Two
C	Benzene	6.5	12.46	Three
D	Ether	4	4.16	One big spot with diffusion
E	Ethyl acetate	4	3.37	One little diffused

Fraction 'A' (Table 1)

The fraction on cooling gave white crystalline solid (1.03 g) and was separated to solid and liquid fractions filtration.

Solid fraction (d-camphene)

The crystalline compound was confined as d-camphene by the preparation of phenylurethane mixed m.p. 139°. I.R. spectrum with an authentic sample.

Liquid fraction

Liquid fraction on GLC gave two peaks which were identified as α and β pinene by comparison. The liquid fraction was fractionally distilled under reduced pressure when following fractions were collected (Table 2).

Table 2

Fraction No.	Boiling range C/10 mm	Weight of the fraction (g)	No. of spots on TLC
A_1	45-50°	2.19	One
A_2	51-55°	1.01	One little diffused

Fraction A_1 (Table 2): β-pinene

The fraction on distillation over metallis sodium gave a TLC pure compound b.p. 156°, n^{26} : 1.4638, which was confirmed as α-pinene by preparation of derivatives and finally by super possible I.R. spectra with an authentic sample.

Fraction A_2 (Table 2): β-pinene

This fraction was identified as β-pinene by co-TLC and comparison of its I.R. spectrum with an authentic specimen.

Fraction B (Table 1)

GLC of the fraction indicated the presence of two compounds which were identified to be zingiberene and ar-curcumene by the comparison of their retention time and co-GLC.

The fraction was subjected to rechromatography over argentation silica gel and eluted with light petroleum (40-60°) and a mixture (4:1) of light petroleum and benzene when two fractions B_1 (3.45 g) and B_2 (1.65 g) were obtained with the successive solvent systems.

Fraction B_1: Zingiberene

The TLC pure fraction giving Ferrex test[3] indicating it to be a hydrocarbon was confirmed as Zingiberene by the preparation of different derivatives.

Fraction B_2: ar-Curcumene

This fraction on heating with Se at 250° for six hours and at 280-300° for another 8 hours, gave a deep blue oil, b.p. 56°, which formed a picrate with m.p. 119°, indicating the fraction to be ar-curcumene. It was confirmed by I.R. spectrum of the fraction.

Fraction C (Table 1)

The benzene fraction, having camphoraceous odour on cooling gave a granular crystalline mass (1.34 g).

Camphor

Confirmed as camphor by preparation of derivatives and super-posable IR spectra with an authentic sample.

Liquid fraction

This fraction on distillation under reduced pressure over a spin band column, gave the following two fractions (Table 3).

Table 3
Weight of the fraction : 11.40 g

Fraction No.	Boiling range C/10 mm	Weight of the fraction (g)	No. of spots on TLC
C_1	80-88°	1.30	One
C_2	89-105°	9.82	One little diffused

Fraction C_1 (Table 3): d-Linalool

The TLC pure fraction gave b.p. 196° giving deep violet colour when shaken with 3 times of its volume of 10% mercuric sulphate solution in 25% sulphuric acid indicating it to be linalool finally confirmed by IR and preparation of derivatives.

Fraction C_2 (Table 3): α-Terpineol

The fraction was b.p. 216°, n^{25}: 1.4805; gave a blue spot on TLC[4], when sprayed with $Sbcl_3$ and $Sbcl_5$ (1:1) and also with phosphomolybdic acid showing the presence of an alcohol, formed a nitrosochloride, which on recrystallization from alcohol melted at 119°. The identity was further confirmed by co-TLC and comparison of its I.R. spectrum with that of an authentic specimen.

Fraction D (Table 1)

The fraction developed a big spot with a long tail on TLC indicating incomplete resolution hence was rechromatographed over alumina grade II and eluted with a mixture of benzene with chloroform (4:1) and finally with chloroform when two fractions D_1 and D_2 were obtained.

Fraction D_1: α-Terpineol

The fraction (0.17 g) was identified as α-terpineol by co-TLC with an authentic specimen.

Fraction D_2: d-Borneol

On removal of the solvent a white crystalline solid (3.97 g) m.p. 204°, $(\alpha)^{27}$ + 35° was obtained, and confirmed as borneol[4] by co-TLC. However, GLC peaks showed the presence of iso-borneol in traces.

Fraction E (Table 1): Zingiberol

The fraction was rechromatographed over a column of alumina (grade II) and eluted with ethyl acetate. On removal of the solvent, a TLC pure fraction was obtained which had b.p. 140-142°/10 mm., $(\alpha_D)^{30}$: + 21°24' and confirmed as Zingiberol by hydrogenation and comparison with I.R. spectrum of authentic sample.

Acknowledgment

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References

1. Kirtikar, R.K. and Basu, B.D.: "Indian Medicinal Plants". 1933, IV, 2439-40.
2. Garg, S.C. and Tripathi, M.K.: "In vitro antifungal activity of some essential oils", Convention of Chemists, 1975, Abstracts. p.135.
3. Janardhan, P.: "Qualitative Organic Analysis", Sarabhai M. Chemicals, 1973, V(2), 19.
4. Stahl, E.: "Thin layer chromatography", Academic Press, New York, 1965, 197.

CHROMATOGRAPHIC ANALYSIS OF THE VOLATILE OIL OBTAINED FROM THE RHIZOMES OF ALPINIA ALLUGHAS Rosc.

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Alpinia allughas[1] (family: Zingiberaceae) is distributed throughout India and is cultivated especially in gardens. The rhizomes are useful in rheumatism, diseases of heart and in Unani system of medicine are efficacious against diabetes and kidney disorders.

Volatile oil derived from sister species of Alpinia[2-9] has been examined as no work seems to have been carried out on A. allughas.

Experimental

Dried rhizomes of A. allughas Rosc. obtained from "Chemical and Allied Products", Calcutta were subjected to hydrodistillation. The volatile oil after usual working was obtained as a yellowish-brown oil (e, 0.05%) analysing for, specific gravity (20°C), -0.8832; refractive index (20°C), 1.4983; optical rotation, 3°45'; acid value, 4.41; ester value, 32.73; and ester value after acetylation, 85.45.

Gas Liquid Chromatography of the Oil

The volatile oil when subjected to g.l.c. in Perkin Elmer 881 (Column, Reoplex 400; column temperature, 150°C, column length, 1.8 m; injection temperature, 240°C, detector, F.I.D. Chart speed, 15 mm/min.; and flow rate 40 ml/min.) analysed for.

Caryophyllene oxide, 23.07%; geraniol, 19.93%; eudesmol, 19.39%; citronellyl acetate, 16.5%; citronellol, 6.8%; β-caryophyllene, 5.45%; α-pinene, 3.84%; linalool, 2.86%; l-α-phellandrene, 1.6%; and geranyl acetate, 0.16% (% calculated by Peak-area method)[10].

Column Chromatographic Analysis of the Oil

The volatile oil (40 g) alumna (1600 g) yielded the following three fractions (Table 1).

Table 1

Fraction	Eluant	Weight (g)	No. of spots on t.l.c. (Argentation silica gel)
A	Pet. ether	15.00	4
B	Benzene	10.00	2
C	Ethylacetate	14.95	3

Fraction A (15 g): It was rechromatographed over silica gel (600 g) and eluted with light pet. ether: benzene 1:3, followed by ethylacetate 2%, in pet. ether resulted in: Fraction A_1 (α-pinene)

Fraction A_1 (α-pinene)

The fraction gave, b.p., 155°/atoms.: d_{20}^{20}, 0.8580; n_D^{20}, 1.4657: ($a_D^{20} \pm 0$. was identified to be dl-α-pinene by co-t.l.c. and also by converting it to pinonic acid having m.p. and m.m.p. 67°C.

Fraction A_2 (l-α-phellandrene)

Following physical constants were recorded for this fraction, d_{20}^{20}, 0.8419; n_D^{20}, 1.4745, $(\alpha)_D^{20}$, -108°26' (CHch). Presence of l-α-phellandrene was established by co-t.l.c. and preparation of its nitrosite derivative.

Fraction A_3 (β-caryophyllene)

The fraction gave one spot on argentised silica gel G plates (5% ethyl acetate) and spraying (sulphuric acid - vanillin). The fraction had the following constants, d_{20}^{20}, 0.8992; n_D^{20}, 1.4976 and $(\alpha)_D^{20}$, -10°2' (CHch). The compound was identified to be β-caryophyllene by co-t.l.c. and conversion to nitrosyl chloride.

Fraction A_4 (Saryophyllene oxide)

The physico-chemical constants of the fraction were recorded as d_{20}^{20}, 0.9663; n_D^{20}, 1.4958; $(\alpha)_D^{20}$, -67°7' and b.p., 138°/2 mm. Its identity as caryophyllene oxide was confirmed by co-t.l.c. and also by super-imposable IR spectra.

Fraction B(10 g)

Over silica gel (400 g) using pet. ether-benzene (1:1) mixture, followed by ethyl acetate 2%, in benzene as eluents gave the following compounds:

Fraction B_1(α-eudesmol)

The fraction had following physical constant, d_{20}^{20}, 0.9884; n_D^{20}, 1.5160; $(\alpha)_D^{20}$, +31°21', (chloroform). The fraction when treated with Hch in acetic acid yielded a crystalline di-hydrochloride, m.p. and m.m.p. 75°C.

Fraction B_2 (d-linalool)

The fraction responded to colour reaction of linalool. The constants recorded for the fraction were, d_{20}^{20}, 0.8354; n_D^{20}, 1.4616 and $(\alpha)_D^{20}$, +14°6' in chloroform. Presence of linalool was also confirmed by co-t.l.c. and preparation of its phenyl urethane derivative.

Fraction C (15.9 g)

It was rechromatographed (14.9 g) over silica gel (600 g) and eluted with ethyl acetate-benzene (9:1) followed by solvent ether furnishing the following compounds:

Fraction C_1 (Citronellol)

The fraction gave reddish-violet spot[11] characteristic of citronellol, on spraying silica gel G plate with mixture of anisaldehyde and sulphuric acid. It had following physical constants, d_{20}^{20}, 0.8558; n_D^{20}, 1.4754; $(\alpha)_D^{20}$, +2°12'.

Presence of citronellol was also established by converting the alcohol into its pyruvic acid ester, the semicarbazone of which melted at 110°C, with no depression in mixed melting point.

Fraction C_2 (Geraniol).

The fraction gave, d_{20}^{20}, 0.8796; n_D^{20}, 1.4758 and $(\alpha)_D^{20} \pm 0$. T.l.c. of the fraction using benzene-chloroform (1:1) as developing agent gave colour reactions[12] with antimony pentachloride, anisaldehyde-sulphuric acid and phosphomolybdic acid. The fraction formed phenyl urethane derivative which after recrystallisation from pet. ether gave m.p. and m.m.p. 81°C.

Fraction C_3 (Citronellyl acetate)

It was found to have the following physical constants d_{20}^{20}, 0.9014; n_{20}^{20}, 1.4428; $(\alpha)_D^{20}$, +2°22'. Its identity was confirmed by positive colour reaction[13] and by co-t.l.c. Further, the hydrolysed product formed pyruvic acid ester, whose semicarbazone gave m.p. and m.m.p. 110°C.

Summary

Volatile oil of Alpinia allughas Rosc., was obtained from crushed rhizomes in an yield of 0.05% by water and steam distillation. The oil was analysed by column chromatography and its percentage composition could be established by g.l.c. However, by column chromatography presence of geranyl acetate could not be established. This may probably be due to its small quantity along with fairly high quantity of geraniol in the oil, which might have hindered its separation or the ester might have hydrolysed.

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References

1. Chopra, R.N., S.L. Nayar and I.C. Chopra. "Clossary of Indian Medicinal Plants", C.S.I.R. publication, New Delhi, Edn. 1956, p.13.

2. Gildemeister, E., and F. Hoffman. "Die Atherischen Ole", Edn. 3rd, Vol. II, p.434.

3. Rao, B.S., M. Mathen, N.C. Kelkar and Jagit Singh. Perfum. essent. oil Rec., 1937, 28, 411.

4. Ruzicka, L., E. Capato and H.W. Huyser, Rec. trav. Chim. 1928, 47, 370.

5. Lawrence, B.M., J.W. Hogg and S.J. Terhune, Perfum. essent. oil Rec., 1969, 60, 88.

6. Schimmel & Co., Berichte, 1910, 10, 138.

7. Nigam, S.S. and C. Radhakrishnan, Riechstoffe Aromen, 1963, 13, 293.

8. "Wealth of India - Raw Materials", C.S.I.R. publication, New Delhi, Edn. 1948, Vol. I, p.63.

9. Goutam, M.P. and R.M. Purohit. Communicated for publication.

10. Mc Nair, H.M. and E.J. Bonelli, "Basic Gas Chromatography Berkeley, California, Edn. 1969, p.139.

11. Seifensider (Muller), Chem. Ztg., 1941, 68, 470.

12. Stahl, E., "Thin Layer Chromatography" Academic Press, Inc., New York, Edn. 1965, pp.485, 486 and 498.

13. Sabetay, S. Riechstoffe Ind. Kosmetik, 1938, 13, 84.

APPLICATION OF PHYSICAL METHODS TO THE ANALYSIS OF ESSENTIAL OILS

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The essential oil chemistry is one of the oldest branches of organic chemistry. The complex nature of the essential oil and the multiplicity of the components present in it has made it a difficult task to analyse the oil quantitatively. Analytical figures obtained seldom represent actual percentages of single constituents. However, the physical methods have revolutionised the essential oil chemistry and made it possible to carry out the analysis with speed and accuracy. The present investigation has, therefore, been undertaken in order to apply some of the physical methods for the quantitative estimation of the constituents present in the essential oils and thus to prove the use of these physical methods as substitutes for the chemical ones, the former having an added advantage over the latter of using smaller quantities of the oil.

The physical methods tried in this connection are (1) Colorimetry, (2) Ultraviolet absorption spectroscopy and (3) Polarography. A summary of the work done is given below:-

A. Colorimetry

Some of the old qualitative colour tests have been quantitatively studied. The core of the estimation procedure lies in the formation of a calibration curve which can serve as a standard for the determination of unknown samples.

(i) α-Terpineol was found to give a beautiful bluish-green colour with vanillin - hydrochloric acid reagent. The colour developed is sufficiently stable and the solution is found to be stable without any turbidity. Thus this colour reaction has enabled the authors to estimate α-terpineol in the following two oils. The values obtained are fairly satisfactory:

Cajuput	-	2.63%
Majorana hortensis	-	14.5%

(ii) An intense green colour is produced when citral is reacted with vanilin - piperidine reagent. The percentages of citral estimated by this method are fairly in agreement with the amount present:

Xanthoxylum alatum	-	2.05%
Lemongrass	-	73.1%

(iii) In the case of furfural, instead of the well-known colouring agent aniline acetate, anthranilic acid has been used which produces a less intense red colour with the terpene. Thus the possible errors due to the high intensity of the colour with aniline acetate is prevented. It has been found that the results obtained are fairly in agreement with the results reported, as obtained by other methods:

Caraway oil	-	1.5%
Cinnamon oil	-	7.29%

(iv) The Pkheidze and Gognadze's colour reaction can also be employed for the estimation of linalool. The terpene produces a red colour with the saturated solution of picric acid and the results obtained are in close agreement with the values already reported.

Ocimum basilicum var. thrysiflorum	-	13.0%
Mexican Linalool wood	-	68.11%
Bois de Rose	-	85.18%

(v) Nerol has been estimated by the E.M. colour reaction (pdimethyl amino benzaldehyde and phosphoric acid in acetic acid constituents the colouring reagent). Geraniol, the isomer of Nerol, also gives this colour test. So, before applying it to the oils, geraniol has been removed by the calcium chloride adduct and then the percentage composition is estimated.

Rose oil	-	8.01%
Citronella oil	-	4.50%

B. Ultraviolet Absorption Spectroscopy

Ultraviolet absorption spectroscopy has not been used much for the quantitative estimations of the terpenes in the essential oils. An attempt has, therefore, been made to estimate the terpenes by spectrophotometry.

Absorption maxima of the following terpenes have been determined.

α-terpinene - 267 mμ; linalool - 228 mμ; thymol - 276 mμ; citronellal - 225 mμ; cit.onellic acid - 226 mμ; piperitone - 235 mμ; α-ionone - 228 mμ; furfural - 271 mμ; safrole - 241 mμ; limonene - 250 mμ.

Some of these terpenes have been estimated in some essential oils.

Linonene in Dill seed oil	- 61.0%
and Xanthoxylum alatum	- 21.5%
Linalool in Ocimum basilicum var. thrysiflorum	- 12.3%
Boise de Rose	- 82.4%
Mexican Linalool wood	- 69.23%
Citronellal in Java citronella oil	- 41.95%
Furfural in Cinnamon oil	- 8.0%
Thymol in Thyme oil	- 17.5%

C. Polarography.

In the present study tetra ethyl ammonium iodide has been used as the supporting electrolyte in studying some of the terpenes. The half wave potentials are shifted to more negative values by this electrolyte.

The terpenes thus studied are: furfural, anisaldehyde, ascardiole, vanillin, pulegone, cineole, cuminaldehyde, salicylaldehyde and citronellal.

Some of these terpenes have been estimated in some essential oils given below:

Cineole in Alpinia galanga	- 5.57%
Cajuput	- 48.15%
Eucaluptus globulus	- 61.62%
Cumin aldehyde in cumin seed oil	- 40.08%
Furfural in cinnamon oil	- 7.7%
Citronellal in Java citronella oil	- 40.0%

ANTIMICROBIAL EFFICACY OF SOME INDIAN ESSENTIAL OILS

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Introduction

Essential oils find an amazingly wide and varied application in many industries for the scenting and flavouring of all kinds of finished consumer products. The germicidal properties of essential oils have been known for a long time.

Antibacterial vapours of volatile substances such as thymol, menthol etc. have been used in respiratory disorders of bacterial origin. Gatti and Cayole found that clove, Peppermint, Camphor, Cinnamon, Eucalyptus, Lavender oils are highly active against S. aureus, S. pyogenes, Asp. albus and Pencillium glaucum. Gattefosse and Donly studied the effect of volatile oils on the acid fast bacteria of tuberculosis and leprosy. The volatile oil of Ocimum sanctum invitro inhibits the growth of mycobacterium tuberculosis and micrococcus pyogens. Similarly Sandalwood, Vetiver, Rose, Neroli, Citronella, Geranium, Bay, Jasmine and Lemon oils have been found active against many micro organisms. Nigam and Rao* have studied the activity of the essential oils of ocimum bacillicum Var. thyrsiflorum, Rosemary, Curcuma amada, Lemon and many species of Eugenia etc. against S. Aureus, S. albus, V. cholerac and E. coli, and have obtained very encouraging results.

In the present study eight essential oils from the seeds of *Carum bulbocastanum*, *Carum carvi*, *Trachyspermum ammi* syn. *Carum copticum*, *Trachyspermum roxburghianum* syn. *Carum roxburghianum*, *Cuminum cyminum*, *Nigella sativa*, from the leaves of *Psidium guava* and from the galls of *Thuja orientalis* have been isolated by steam and water distillation method and tested for their activity against nine fungi *Aspergillu flavus*, *A. fumigatus*, *A. versicola*, *A. oriza*, *Trichoderma viride*, *Fusarium tenus*, *Curvularia*. Sps. *Penicilium javanicum* and *Penicillum funiculosum* and 6 bacteria - *Escherichia coli*, *Staphylococcus aureus*, *S. typhi*, *S. paratyphi*, *Basillus subtilus*, *Shigella nigar*, using agar diffusion technique**.

*Rao, B.G.V.N. & Nigam S.S., Flavour Industry, 1970, I, 725

Various methods have been proposed for knowing the activity of the essential oils against the pathogens from time to time.

Agar - diffusion method has been used for the present investigations, and Potato - Dextrose - Agar (P.D.A.) medium has been used for the preparation of slants and for agar plates for testing the activity of fungal pathogens.

***Emerson's medium has been used for studying the activity of bacteria.

Weighed quantities of the ingredients were mixed and the media was sterilised by autoclaving at 15 lbs pressure for 30 minutes and cooled to 40°C thereafter. Homogenious suspension was prepared by transferring aseptically a few loop fulls of spores to the medium followed by thorough shaking. 20 ml. to 25 ml. of this medium was poured into each petridish which had already been sterilised at 140° for 48 hours and allowed to gel. After gelling paper discs prepared from whatman No. 1 filter paper and soaked in the essential oils, were placed on the seeded agar plates. The bacteria were then allowed to grow at 37°C in an incubator and the results were noted after 24 hours and 48 hours. In the case of fungi observations were taken after incubation of 48 and 65 hours at 27°C.

Conclusion

Thus it is found the essential oil isolated from the galls of Thuja orientalis has been found to be active against almost all the pathogens. The essential oils isolated from the seeds of *Trachyspermum* ammi, *Nigella sativa*, *Carum*, *Carvi*, *Cuminium cyminum* and *Trachyspermum roxbughianum* have shown good activity against some pathogens. *Penicilium javanicum* has been found to be the most resistant pathogen, whereas *Fusariam tenus*, *S. paratyphi* have shown the easy susceptibility. The essential oil isolated from the galls of *Thuja orientalis* can be used as a good fungicide.

The work is in advance and the individual compounds of the oil of *Nigella sativa* are being worked. By this we can pinpoint the individual active terpenes and they can be used as fungicides and bacteriocides.

** Jasper, C. Maruzzeila & Henry, P.A., J. Am. Pharm. Assoc, 1958, 47, 471.

***Selman A. Waksman,' The Actinomycetes', Vol.II, 1961, 331.

Activity of the Essential Oils against Bacteria in mm.

	E. coli	S. aureus	S. typhi	S. paratyphi	Shigella -nigar	B. subtilus
Carum copticum	-	-	50	54	-	-
C. bulbocastanum	17	-	15	12	-	18
C. carvi	16	12	19	50	-	13
C. roxburghianum	15	29	-	18	-	26
Cuminum cyminum	-	-	-	-	-	-
Nigella sativa	50	30	-	54	-	-
Psidium guava	17	16	18	14	-	15
Phuja orientalis	22	23	28	16	30	24

The diameter of the paper disc. -- 9 mm.

Activity of the Essential Oils against Fungal Pathogens in mm.

	Asp. flavus	Asp. fumi-gatus	Asp. versi-cola	Asp. Oriza	Fusa-rium tenus	Tricho-derma viride	Curvu-laria	Pen. Javani-.cum	Pen. funicu-losum
Carum copticum	-	-	-	-	13	-	-	-	-
C. bulbocastanum	-	20	-	-	-	20	10	-	-
C. carvi	13	15	14	20	24	15	24	-	-
C. roxburghianum	13	25	-	18	30	19	30	-	-
Cuminum cyminum	-	23	-	-	32	30	-	-	-
Nigella sativa	22	-	13	-	20	10	-	-	-
Psidium guava	17	16	17	12	25	11	16	11	14
Thuja orientalis	24	28	58	19	45	29	36	12	32

The diameter of the paper disc. -- 9 mm

ESSENTIAL OIL RESOURCES FOR TERPENE CHEMICAL INDUSTRIES

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The entire Himalayan forest belt, extending from Kashmir to Assam covering an area of 80,00,000 hectares is endowed with natural forests rich in Pine Trees. Of these the total area occupied by Pine Forests is 10,00,000 hectares. Pine Trees exude Oleo Resin gum, a very valuable basic raw material for a wide variety of consumer - oriented industries. The resin when processed forms two major constituents - ROSIN and TURPENTINE which are materials of considerable importance. Rosin is used as a raw material in a host of industries - including paper, soaps, paints and varnishes, adhesives and synthetic rubber. Turpentine, traditionally used as a solvent for paints and varnishes, has now been developed as one of the most essential and versatile raw materials for various terpene based chemicals finding use in the manufacture of such essential commodities of every day life as paper; textile; soaps and perfumery; detergents; paints; varnishes and lacquers; rubber and adhesives; leather tanning; polishes and other goods which are vital for economic and industrial development of India.

The Pine resin or Oleo resin gum industry is commonly referred to as 'NAVAL STORES' in the world. The 'Oleoresin gum' after tapping and collection undergoes steam distillation to yield spirit or oil of turpentine and 'Rosin or Colophony'. For obtaining higher yields, uniform and better quality of turpentine and rosin, continuous steam distillation plants are now in operation all over the world, based on "Olustee Process".

Out of the four species of pine trees, the main species exploited for pine resin tapping is Pinus Roxburghii or Chirpine. Some tapping is also done on PINUS KHASIYA or Khasi pine, but the major portion of the forests covered by this specie has yet to be thoroughly exploited. The forests of PINUS GERARDIANA or chilgoza Pine are so small and scattered that no tapping work can be undertaken, while PINUS WALLICHIANA or Kail Pine faces

difficulties of tapping due to labour problem and high altitudes. However, the potential for increasing the tapping is still immense and further improvements are possible in various areas employing sophisticated techniques.

The processing of Oleo-Resin-Gum in the country is undertaken by four large scale Government units, one co-operative unit and around 30 small scale distilleries. The combined processing capacity of all the Government and private units is estimated at 60,000 tonnes of Oleoresin against the current 54,000 tonnes. The production of Oleo-resin has not been sufficient for the Rosin and Turpentine producers to work their units to full capacity. Table I gives the production of Oelo-resin, rosin and turpentine:

Table 1

Production of Oleoresin, Rosin and Turpentine

Figures in Tonnes

Year	Oleoresin	Rosin	Turpentine
1964-65	30,265	22,685	4,840
1965-66	37,980	28,480	6,077
1966-67	49,322	36,965	7,889
1967-68	45,233	33,915	7,234
1968-69	42,302	31,700	6,766
1969-70	43,607	32,627	6,963
1970-71	43,250	33,000	7,000
1971-72	38,200	29,000	6,000
1972-73	48,900	37,000	8,000
1973-74	54,000	41,000	8,700
1974-75 (Estimated)	60,000	45,000	9,000

Turpentine - Present and Future

Turpentine oil is a very valuable and versatile basic raw material for the production of host of terpene chemicals apart from a group of other products with possibilities of varied industrial utilization. The technology of terpene synthesis had advanced so fast that perfumery chemicals made from the various constituents of Turpentine oil have virtually replaced or duplicated all "isolates" which were derived from Natural Essential oil, till only a few years back. The emergence of synthetic products thus has erased the fear of short and irregular supplies.

The terpene chemical industry in India could not be developed perhaps due to low pinene content and also insufficient scientific knowledge of the other constituents, viz. Delta-3-Carene and Longifolene. In other parts of the world most of the terpene chemicals have been derived either from Alpha-Pinene or Beta-Pinene which are the major constituents of turpentine in general.

Table II gives typical composition of turpentine from some selected countries:

Table II

Percentage Chemical Composition of Turpentine Oil in the World

	U.S.A.	FRANCE	INDIA	USSR	SWITZERLAND
Alpha-Pinene	65-75	60	20-30	75	80
Beta-Pinene	20-25	25-30	5-10	-	5-7
Delta-3-Carene	-	-	55-65	15	15
Longifolene	-	-	2-5	-	-
Other terpenes	10	10	3-5	10	10

The above clearly shows that the pinene is only 20-30% in Indian turpentine which is a very low content for establishing any terpene chemical industry based on pinene, so much so that the indigenous production of camphor, which was imported in large quantity every year was considered to be economically unfeasible.

Considerable work was done by various laboratories all over the country and considerable interest was taken by various entrepreneurs. However, it was only with the courage, determination, initiative and pioneer efforts, a Camphor Plant, the first of its kind in Asia, was put up at Clutterbuckganj, Bareilly, U.P. in 1961 and since April, 1964 both technical and pharmaceutical grades of camphor are being produced on a regular basis to meet the entire demand of the country, resulting in the saving of foreign exchange to the tune of Rs 5 to 6 million per annum. With the development of the Camphor Project extensive research and development work has opened the door for other major constituents of Indian turpentine viz. Beta-Pinene, Delta-3-Carene and Longifolene which was resulted in a host of perfumery chemicals, pharmaceuticals, insecticides and synthetic resins. A short study of the great potentialities of all important terpenes of Indian turpentine oil, i.e., Alpha-pinene, Beta-Pinene, Delta-3-Carene and Longifolene would clearly show the vital role turpentine is playing in the industrial and economic development of our country.

Alpha-Pinene and Beta-Pinene

Both Alpha-Pinene and Beta-Pinene are considered among the most valuable known Bicyclic terpenes and have been utilised for terpene chemical synthesis for many decades in nearly all the major developed countries like U.S.A., U.K. and U.S.S.R. Perfumery chemicals like terpineol and its esters, isoborneol, borneol and their esters particularly acetates derived from camphene which is obtained by catalytic isomerization of pinenes,

Allo-Ocimene, its alcohol and ester; verbenol, verbenone, Nopol and Nopyl Acetate; Myrcene, which further leads to Linalool and esters; Hydroxy citronellal, Citral, Ionones, Irones, Isopulegol; Menthol etc. are being manufactured to meet the requirements of the perfumery and flavour industry.

Camphene which is an important product of isomerization of both Alpha and Beta pinenes is not only the basic raw material for the manufacture of camphor, in addition it has led to the development of synthetic sandalwood oil and cedarwood oil. Synthetic sandalwood oil from camphene is already in the world market. Isobornyl thiocyano acetate (thanite) and chlorinated camphene (toxapene) are very powerful insecticides and pesticides for the control of household insects and agricultural pests.

Both Alpha and Beta pinenes are excellent raw materials for the manufacture of terpene phenol and polyterpene resins. Important terpene based industrial undertaking like Hercules Powder Co., Pennsylvania; Industrial Chemical Corporation, Arizona; Tenneco Chemicals, etc. are having large scale production of these resins which find extensive use in the manufacture of pressure sensitive adhesives tapes and other adhesives, rubber, paints and varnishes, polishes, printing inks, polishes, chewing gums, neoprene cements.

Although the availability of Alpha Pinene is insufficient, the production of the following items has been regularly on a large scale for the last several years, meeting the entire requirements of the country:

a) Camphor
b) Isoborneol and Isobornyl Acetate
c) Terpineol and Terpinyl Acetate
d) Pine Oil
e) Isobornyl Thiocyano Acetate

The recent development in fractionation of turpentine oil to produce Beta-Pinene of high purity has led the way for the manufacture of the most valuable and important terpene chemical from Beta-Pinene, which include polyterpene resins and all open chain perfumery chemicals like Linalool, Geraniol, Nerol and their esters. Manufacture of polyterpene resins has already started, and very soon a new plant to manufacture open chain terpene alcohols would be on the way.

Dipentene, a by-product of camphor and pine oils manufacture has been successfully converted into Para-menthane and then to Para-menthane Hydroperoxide which is a valuable initiator in the cold rubber manufacture and is imported to the tune of 60 tons per

annum. Indigenous production of Para-menthane hydroperoxide has already started.

Thus the country is becoming self-reliant in most of the products based on Alpha and Beta-Pinene, amounting to more than Rs 12 million saving of foreign exchange already.

Delta-3-Carene

After removing pinenes from Indian turpentine oil and roxburghii, 70-75% mixture of Delta-3-Carene and sesquiterpene longifolene is obtained which is composed of 80% Delta-3-Carene. From the present annual production of about 9,000 tons of turpentine about 4800-5600 tons of Delta-3-Carene could be made available on fractionation.

The versatility of Delta-3-Carene as a potential raw material for terpene chemicals synthesis is now very much established. Processes have been developed for a variety of perfumery chemicals, polyterpene resins, terpene-phenol resins, cymens, cresols, thymol and methol etc.

Production of all these chemicals would amount to net foreign exchange saving of more than Rs 15 million per annum because many of the products are imported or many other allied imported products can be successfully substituted. Besides, there is ample promise for export of non-traditional items in the field of chemicals and chemical intermediates. During the past several years extensive research work has resulted in the development of several perfumery chemicals with odours as pleasant citrus camphoraceous, wetgrassy, fruity floral reminiscent of Gardenia flower. All these products have great export potential as shown by market evaluation. A terpene phenol resin has also been developed which is finding tremendous application in paints, varnishes, coatings, polishes, rubber, adhesives, printing inks, electric insulation etc. and would replace to a very large extent coumarone indene and escorez resins and many other resins specially phenolic resins which are imported. Indigenous production of terpene phenol resins has already started and that alone would save a foreign exchange of more than Rs 3 million per annum.

Delta-3-Carene has been successfully aromatised with a mixture of Para-Meta Cymenes, which in turn would lead to the manufacture of cresols and acetone via cymene hydroperoxide.

Production of menthol from Delta-3-Carene, has been established on laboratory scale and further research work is in progress. It is hoped that very soon synthetic menthol from Delta-3-Carene would be in market.

Longifolene and Isolongifolene

Besides Pinenes and Delta-3-Carene, Indian turpentine oil Ex-Pinus Roxburghii contains about 2-5 per cent longifolene. Longifolene is the wonder constituent of Indian Turpentine oil. Of late longifolene has attracted considerable attention from perfumery industry and scientists abroad. On acid isomerization, longifolene gives isolongifolene which has acquired great potential as shown by recent research work in India as well as abroad. India is the largest producer of both longifolene and isolongifolene and if export is developed properly, it is expected that more than Rs 10 million can be earned as foreign exchange from longifolene and 60-75 tons of isolongifolene can be made available indigenously. Some quantities of both of these terpenes have also been exported during the past 5-6 years.

Extensive research work in the country in the past ten years has resulted in production of several perfumery chemicals from both longifolene and isolongifolene having sweet and pleasant woody odours, odours reminiscent of vetiver oil, odour reminiscent of patchouli oil etc., thus making way for extensive use in perfumery blends of sandalwood, vetiver and patchouli oil type. Most of these products have acquired a great market value both internally and abroad and are finding general acceptance in the perfumery, soaps and cosmetic industry.

Turpentine Residue

The residue of pitch left after removing various terpenes from turpentine oil also has been utilised in the manufacture of pine tar of several types. Pine tar is a very valuable plasticizer, tackifier and softener used in the manufacture of rubber goods. Several grades of pine tar equivalent to almost all imported pine tars are already being produced in India which has resulted in the saving of foreign exchange to the tune of Rs 1.5-1.7 million per annum.

The last almost 14 years has thus seen the growth of terpene chemical industry in India, which has made very valuable contribution in moulding the economic structure of the country. But the requirement of terpene based chemicals is ever increasing and the current production of turpertine oil is not sufficient to utilize the full licensed capacities of the pine chemical units.

To utilize the idle capacity the proposed requirement of turpentine could go upto 12,000 tons in 1980. It is anticipated that by the end of 1985, the requirement of turpentine would be doubled. The oleoresin requirement would be around 120,000 tons.

The terpene chemical industry on full development would save foreign exchange worth more than Rs 30 million. This is a clear indication of the role this industry has played and would play in the context of the country's economy and industrial development.

PHARMACOLOGICAL STUDIES ON ESSENTIAL OIL OF CYPERUS SCARIOSUS R. Br.

I. Effect on Central Nervous System

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Abstract

The pharmacological studies of the essential oil demonstrated that it had a depressant effect on the central nervous system of rats and mice. The essential oil blocked CAR in 50 per cent animals and potentiated the effects of chlorpromazine on CAR and pentobarbitone-induced hypnosis. The analgesic action and the potentiation of morphine-induced analgesia due to the essential oil was also marked. The essential oil checked the tonic hind limb extension produced by electric shocks but failed to check strychnine and metrazol induced convulsions.

The rhizomes of several species of Cyperus (Family: Cyperaceae) are frequently used in the indigenous medicine and the essential oil of those which are aromatic in nature appears to be responsible for some of the reported uses. The rhizomes of C. acariosus are reported to be pungent, acrid, tonic, demulcent, diuretic, anthelmintic, diaphoretic and vermifuge. A decoction of the rhizomes is used in gonorrhoea and syphillitic conditions[1-3]. According to Naves[4] the essential oil contains 40 per cent of tricyclic sesquiterpene and 33 per cent of bicyclic sesquiterpene ketones. Since no investigation has been done on the pharmacological effects of the essential oil, it was though worthwhile to study the same.

Experimental

After the identification of the plant the rhizome were subjected to steam distillation to yield essential oil (0.35%).

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The essential oil was emulsified with 3% aqueous polysorbate-80 and passed through a hand homogeniser to give a 5% emulsion. Further dilutions were made in physiological solutions or distilled water. The solutions of chlorpromazine hydrochloride, pentobarbitone sodium, morphine hydrochloride, strychnine hydrochloride and amphetamine sulphata were made in distilled water. All the drugs were administered intraperitoneally and appropriate control experiments were performed simultaneously. All the experiments were performed at least in triplicate and at room temperature (25 $\pm$ 1.5°C).

Cross Behaviour of Albino Rats[5]: The albino rats were divided into 4 groups of 10 animals each and kept in separate metallic cages with wire meshed walls and injected with the essential oil (75 and 150 mg/kg), chlorpromazine hydrochloride (5 mg/kg), and 3% polysorbate-80 (4 ml/kg) respectively. The cages were numbered and the animals were left undisturbed for 30 minutes. The signs of C.N.S. depression were then observed 30 and 60 minutes after the administration of various drugs and thereafter at hourly intervals for 4 hours.

Conditioned Avoidance Response of Trained Rats: The technique described by Cook and Weidley[6] was followed for the study. The animals were divided into 5 groups of 10 each and injected with the essential oil (75 and 150 mg/kg), chlorpromazine hydrochloride (5 mg/kg), essential oil and chlorpromazine hydrochloride (150 mg/kg and 5 mg/kg), and 3% polysorbate-80 (4 ml/kg) respectively. The animals were tested 30 and 60 minutes after the administration of various drugs and thereafter at hourly intervals for 6 hours.

Pentobarbitone-induced Hypnosis in Albino Mice: The method of Dandiya and Cullumbine[7] was followed. The albino mice (weight 20-25 g) were divided into 3 groups of 10 each and injected with the essential oil (75 and 150 mg/kg) and 3% polysorbate-80 (4 ml/kg) respectively. The animals of all the three groups were then given pentobarbitone sodium (25 mg/kg) 15 minutes later and gently put on their backs as soon as they fell asleep. The time interval between the loss and return of righting reflex was noted and the recovered animals were removed to avoid disturbance to their neighbours.

Rotarod Performance of Albino Rats: The albino rats were trained to remain for a minimum period of 2 minutes on a cylinder (15 cm diameter) revolving horizontally at the rate of 4 revolutions per minute. The animals were tested for their efficiency before studying the effect of essential oil and divided into 4 groups of 10 each. They were then injected with the essential oil (75 and 150 mg/kg), chlorpromazine hydrochloride (5 mg/kg), and 3%

polysorbate-80 respectively. The animals were tested for their rotarod performance 30 and 60 minutes after the administration of various drugs and thereafter at hourly intervals for 4 hours. The number of animals falling down during the 2-minute test period was noted.

Rectal Temperature of Rats: The rectal temperature of groups of 10 animals each was recorded using a clinical thermometer. Two groups were given essential oil (75 and 150 mg/kg respectively) and the third group was treated with 3% aqueous polysorbate-80 (4 ml/kg). The temperature was again recorded after 30 minutes and at hourly intervals thereafter for 4 hours.

Metrazol, Strychnine and Electric Shock-Induced Convulsions: The albino rats were divided into 3 groups of 10 animals each and injected with the essential oil (150 mg/kg). Thirty minutes later, the animals of the respective groups were given strychnine hydrochloride (2.5 mg/kg) and metrazol (80 mg/kg) by subcutaneous route, and electric shock through corneal electrodes with a current of 120 M.A. for 0.2 seconds. Three additional groups served as control. The tonic hind limbs extension was taken as the end point.

Amphetamine Aggregate Toxicity in Albino Mice: The albino mice were divided into 2 groups of 5 animals each. One group of the animals was injected with the essential oil (150 mg/kg) followed by amphetamine sulphate (8 mg/kg) 30 minutes later. The second group of animals was given amphetamine sulphate (8 mg/kg) alone. The animals of the respective groups were kept in 2 separate metallic cages and the mortality was recorded after 24 hours.

Motor Activity in Albino Mice: The albino mice were divided into 2 groups of 5 animals each. The animals of the respective groups were then placed in an actophotometer and their movements during a 10-minute period recorded. One group of the animals was injected with the essential oil (150 mg/kg), whereas the other with 3% polysorbate-80 (4 ml/kg). The movements of animals in both the groups were again recorded 30 minutes after the administration of drugs.

Pain-threshold of Rats: A hot-wire analgesiometer was used for determining the pain threshold of rats according to the method of Dandiya and Menon[8]. The animals were divided into 5 groups of 10 each and injected with the essential oil (75 and 150 mg/kg), morphine hydrochloride (4 mg/kg), essential oil and morphine hydrochloride (75 mg/kg and 4 mg/kg), essential oil and morphine

hydrochloride (150 mg/kg and 4 mg/kg) and 3% polysorbate-80 (4 ml/kg). The reaction time of the animals was noted 30 and 60 minutes after the administration of drug and thereafter at hourly intervals for 4 hours.

Pyresis in Albino Rabbits: The albino rabbits divided into 2 groups of 5 animals each were used regardless of sex. The normal body temperature variations of the individual animal were recorded on two occasions at an interval of 1 week before any drug was tested. The rabbits were deprived of food but not water overnight before starting the experiment. The pyrexia was then produced by the intravenous administration of 0.1 ml of T.A.B. vaccine through the marginal vein. The temperature of the animals in the respective groups was recorded at hourly intervals for 4 hours with the help of multichanneled electronic thermometer after the oral feeding of the essential oil (150 mg/kg) and 3% polysorbate-80 (4 ml/kg).

Results

The signs of C.N.S. depression were observed in the rats treated with the essential oil. The animals treated with the essential oil moved with an unsteady gait. The response to pain and touch stimuli was considerably reduced but the response to sound was only slightly affected. The awareness and righting reflex were also markedly affected with higher dose. The depressant effect lasted for 4 hours with no mortality within 24 hours and the overall action with 150 mg/kg was comparable to that of chlorpromazine hydrochloride (5 mg/kg). The peak action of the oil was recorded 30 minutes after its administration.

The essential oil (150 mg/kg) blocked the CAR in 50 per cent of animals and it potentiated the action of chlorpromazine hydrochloride (5 mg/kg).

The essential oil (150 mg/kg) potentiated the hypnosis caused by pentobarbitone sodium to the extent of 60%.

The essential oil (75 and 150 mg/kg) affected the rotarod performance of animals, the number of animals falling from the cylinder being 50 and 80% respectively. The overall action of the oil was less when compared with that of chlorpromazine hydrochloride (5 mg/kg).

The hypothermia due to the essential oil (75 and 150 mg/kg) was relatively less significant (1.12 and 1.520).

The essential oil did not offer any protection against strychnine and metrazol induced convulsions in the rats but prevented the tonic hind limb extension produced by the electric shocks. The extension being checked in 80 per cent of the animals.

The essential oil generally delayed the onset of the action of amphetamine sulphate but the mortality rate remained unaffected.

The essential oil (150 mg/kg) depressed the motor activity in the albino mice, the movements being reduced from 493 to 188.

The number of animals showing analgesic effect 30 minutes after the administration of the essential oil (150 mg/kg) was 60 per cent. The analgesic effect was however slightly less compared to morphine hydrochloride (4 mg/kg). The essential oil potentiated the analgesic action of morphine hydrochloride.

The antipyretic activity of the essential oil was not significant.

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References

1. The Wealth of India, Raw Materials (Vol. II), CSIR, New Delhi, 1950, p. 425.
2. Kirtikar, K.R. and Basu, B.D.: Indian Medicinal Plants, Vol. IV, CSIR, New Delhi, 1933, p. 2637.
3. Chopra, R.N., Nayar, S.L. and Chopra, I.C.: Glossary of Indian Medicinal Plants, CSIR, New Delhi, 1956, p. 89.
4. Naves, Y.R., Bull. Soc. Chim., France, 1954, 330; Through C.A., 1955, 4, 237 d.
5. Chandhoke, N. and Ray Ghatak, B.J. : Ind. Jour. Med. Res., 1969, 57(5), 864.
6. Cook, L. and Weidley, E.: Ann. N.Y. Acad. Sci., 1957, 66. 740.
7. Dandiya, P.C. and Cullumbine, H.: J. Pharmacol. Exp. Ther. 1959, 125, 353.
8. Dandiya, P.C. and Menon, M.K.: Arch. int. Pharmacodyn. Ther. 1963, 141, 223.

SCOPE OF ESSENTIAL OIL INDUSTRY IN U.P. AND ITS FUTURE PROSPECTS

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India has been well known from times immemorial for its perfumery products and U.P. has been the pioneer of this industry. Kannauj, Jaunpur, Ghazipur, Bermana and Hassayan (in District Aligarh) were the famous centres of production, wherefrom the essential oils and attars used to be exported to foreign countries.

It was during the last century that our country lost its dominating position in the export market due to inefficient distillation and uneconomic cultivation of essential oil plants as also due to our failure to note the changing times and inability to keep pace with the scientific developments during the period of industrial revolution. In addition to these, the introduction of cheaper aromatic chemicals and synthetic essential oils having odours similar to natural essential oils further hit our industry.

Since the time of Independence, efforts have been made both by Government and by public bodies to revive and develop this industry. Essential Oils Research Committee under C.S.I.R. encouraged the cultivation of several aromatic plants. The Government of U.P. also sanctioned "Essential Oil Scheme" at Harcourt Butler Technological Institute, Kanpur to assist the perfumers for the development of essential oil industry. Considerable work was done by growing some exotic perfume bearing plants in the State e.g., lemongrass, Palma rosa, Mentha arvensis and M. piperita. Essential oils from several flowers, e.g., J. grandiflorum, J. sambac, J. auriculatum, M. champaca L., Tagets erecta and Patula, Nyctanthes arbortristes, Mimusops elengi, Anthocephalus cadamba and rose etc. were prepared for the first time and examined. Besides these, the oils from leaves of Ocimum sanctum, O. basilicum, Mentha arvensis, M. piperita etc. were also distilled and examined. An improved type of still was also designed. The Scheme was wound up in 1967.

Forest Research Institute, Dehra Dun, Indian Institute of Science, Bangalore and National Chemical Laboratory, Poona, D.S.B. College, Naini Tal and Saugar University, Sagar, also carried out examination of several essential oils from seeds, roots and flowers of aromatic plants. National Botanic Gardens, Lucknow successfully cultivated perfume bearing plants in usar land. Recently Central Indian Medicinal Plants Organisation in its branches has done valuable work on certain exotic plants. Mention may be made of Citronells grass (Java type), improved variety of lemon grass, Palma rosa, Mentha arvensis, Mentha citrata and Linaloe etc. The cultivation of the above plants is being done on a large scale and the essential oils obtained from them can meet the industrial demands of the country to a great extent.

The present production of main essential oils in India is estimated as follows:-

1.	Cinnamon leaf oil	3	tonnes
2.	Citronella oil	200	-do-
3.	Eucalyptus oil	10	-do-
4.	Ginger grass oil	5	-do-
5.	Geranium oil	2	-do-
6.	Himalayan Deodar oil	15	-do-
7.	Lemon grass oil	600	-do-
8.	Linaloe oil	2	-do-
9.	Mentha arvensis oil	40	-do-
10.	Palma rosa oil	55	-do-
11.	Sandalwood oil	100	-do-
12.	Vetiver oil	5.5	-do-

India exports essential oils worth Rs 4-4.5 crores annually, out of which sandal wood oil accounts for Rs 3.0 crores approximately. Other main oils exported are lemongrass, palma rosa and vetiver etc. A number of essential oils are also imported to meet the industrial demand of the country. The import of main oils is given in Annexure 'A' attached.

It can be observed from the table that oils of Bergamet, Citronella, Geranium, Lavender, Orange, Patchouli and Peppermint are imported in bulk quantities. It is gratifying to note that Central Indian Medicinal Plants Organisation and Regional Research Laboratory, Jorhat, have encouraged cultivators and tea planters to take up the cultivation of Citronella grass and Mentha arvensis. It is hoped that the production of these oils will meet the demand of the country.

As regards Bergamot oil, it was noticed that the oil from the peels of hilly lemons of U.P. was similar to the former in tone. Attempts should be made to develop this industry in hilly regions.

Appendix 'A'

IMPORT OF NATURAL ESSENTIAL OILS

Names of oils	1969-70		1970-71		1971-72		1972-73		1973-74	
	Qty. in Kg.	Value in Rs.	Qty. in Kg.	Value in Rs.	Qty. in Kg.	Value in Rs.	Qty. in Kg.	Value in Rs.	Qty. in Kg.	Value in Rs.
Anise	7878	1,29,973	4258	90,778	19088	4,16,649	4907	1,11,327	7832	1,87,664
Bergamot	6477	5,52,624	6577	7,84,929	6363	5,30,050	5525	5,83,726	36435	37,66,962
Cinnamon leaf	4630	1,01,833	8373	1,63,368	6934	1,32,726	13977	2,66,770	9236	1,16,982
Citronella	122999	17,04,292	56398	12,97,559	21877	4,88,215	93873	19,81,890	69549	18,94,147
Clove	24652	5,44,428	37544	9,35,308	33694	8,48,716	40880	9,87,489	32752	9,64,948
Geranium	10311	14,13,526	9055	12,43,313	10532	15,27,110	12571	20,86,946	15488	30,27,867
Lavender	9103	5,41,480	16623	7,85,426	23266	11,12,423	12969	7,74,567	21160	14,65,470
Lemon	15873	3,64,107	16860	3,93,946	18602	5,25,591	21183	4,78,093	21395	7,68,288
Orange	22152	3,51,271	56646	5,96,504	12936	3,43,033	28418	3,94,022	97949	11,63,386
Patchouli	18985	8,41,754	22764	9,72,634	24289	11,93,322	28622	15,48,698	60738	36,23,902
Peppermint							53424	26,38,509	48762	33,04,802
Mentha arvensis / Mentha piperita	138125	54,98,007	121838	45,61,683	159017	86,10,780	53716	22,16,618	53399	23,33,206
Spearmint	4357	4,34,925	1453	1,64,763	7651	6,70,753	7767	7,64,961	10057	7,52,692
Ylang ylang	3765	3,20,279	2353	2,39,372	4256	3,45,717	3552	3,44,255	3428	3,87,238
Dementholised Peppermint oil								7,47,889	601	44,589

Geranium plants can be grown in areas near Ranikhet. It was learnt that it had its wild growth in that area, but in course of time it was uprooted to clear the land. The area is quite suitable for its cultivation. Efforts should be made to cultivate Lavender in hilly tracts of the State. Mentha citrata, recently discovered by CIMPO, produces an oil similar in properties to Lavender oil. The plains of our State are suited for the cultivation of Mentha arvensis, M. piperita, Citronella grass, Mentha citrata, Palma rosa, Lemon grass and Vetiver. There are vast tracts of barren lands or alkaline soil which can profitably be used for cultivation of perfume bearing plants without removing their alkalinity. The names of plants to be cultivated can be had from National Botanic Gardens, Lucknow. Systematic endeavours may be made to make lemon and orange oils in factories, where canning of these fruits is done. Proper type of spearmint should be grown, so that its oil may satisfy I.S.I. specifications. In H.B.T.I.,garden, a special variety of spearmint was grown and its oil was very much appreciated by a foreign concern. U.P. is quite suitable to grow most of the plants, whose oils are imported in the country. In case of over-production, they can be exported to other countries.

It need not be emphasized that essential oils, formerly considered as luxury items, are now the necessities of life owing to their applications in products of every-day life. The demand is bound to increase with the increase in toilet and cosmetic articles and also with the increase in population. Therefore, there is a bright future for perfumery products and essential oils in the country.

IMPROVED TECHNIQUES OF DISTILLATION OF ESSENTIAL OIL-YIELDING CROPS OF KERALA

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Indian aromatics have held sway the world for many centuries. According to one report, Mary Queen of Scots used delicate Indian scents to perfume her baths four hundred years ago. But even today it is the Indian grasses that help to perfume the costly toilet soaps all over the world. The pride of place among the essential oils earning the major portion of the foreign exchange goes to the oil of lemongrass (Cymbopogon flexuosus). Records show that as early as 1890 over 10 tons of lemongrass oil was exported from Cochin in Kerala. Kerala is having the monopoly in the cultivation of East Indian lemongrass and in the production of oil. An area of 29,000 hectares is estimated under the lemongrass crop. Other essential oil yielding plants cultivated in Kerala are:

1. Vetiver (Vetiveria zizenioides)
2. Palmarosa (Cymbopogon martini)
3. Eucalyptus (Eucalyptus citriodora)
4. Cintronella (Cymbopogon nardus)

The oil secretion in essential oil yielding crops are produced in the cells in the region of metabolic and photosynthetic activity. They are located in different parts of the plants namely roots, stems, leaves, flowers and fruits. The industry divides distillation of essential oil yielding crops into three types: water, water and steam and direct steam. With the method called water distillation, plant material is in direct contact with boiling water. Heat is introduced into the still by conventional means of direct firing. The second method employs a grid or a false bottom to hold the plant material which is in contact with saturated steam only. Direct steam distillation also uses a supporting grid. Live

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steam saturated or superheated is fed into the still below the charge. According to Sadagopal (1962) three things happen at once during distillation. Essential oils and hot water diffuse through the plant membranes, some components of the oils hydrolyse and part of the oil is decomposed by heat. The ideal distillation is one in which the diffusion rate is as high as possible while hydrolysis and thermal decomposition are kept minimum.

The crude direct fire still consists of a truncated cone placed over copper cylinder with a man-hole towards the bottom for charging and discharging the plant material. A mud and brick hearth serves as the furnace. A spiral condenser remains immersed in a wooden barrel filled with cold water. The mixture of vapour and essential oil collects in a receiver. As an improvement the coil is replaced by vertical coolers with several straight tubes. Cooling is carried out by enclosing the whole condensation system in a reservoir in which the cold water enters the bottom part and leaves through the upper part.

The yield of essential oils from crops depends upon the soil, climate, frequency of harvest, pre-treatment before distillation, method of distillation and recovery of oil (Guenther).

Frequency of harvest

The time of harvest of the plant material for distillation is an important conditioning factor for successful distillation. For local varieties of lemongrass the optimum interval between harvests is 45-55 days (Chinnamma and Menon, 1973). In the case of OD-19 on hill tops the interval is 55-60 days (Sreedharan and Chandrasekharan, 1973). In eucalyptus the leaves can be harvested during the pre-monsoon and post-monsoon periods (Nair, 1974). The citronella is harvested at an interval of 90 days. Vetiver is harvested 17-19 months after planting (Sreedharan and Chandrasekharan, 1973).

Pre-Treatment

Pre-treatment of the material before distillation is an important prerequisite for efficient distillation. Wilting and drying of harvested lemongrass have been found to increase the quantity of oil produced (Chinnamma and Menon, 1973). During the wilting and drying the cell-membranes gradually break-down and the liquids are free to penetrate from the cell to cell (Guenther). An experiment was laid out in the Lemongrass Research Station, Odakkali in OD-19 types of lemongrass with 4 wilting treatments (distilling fresh grass 48, 96 and 144 hours after harvest) and 4 chopping treatments (distilling unchoped grass and those chopped to 3, 10 and 20 cm lengths). The data on the yield of oil amd citral content are presented in Tables I and II.

Table I

Mean oil yield of Lemongrass (ml) for the different chopping and wilting treatments

Chopping treatment	No. wilting fresh grass	48 hours wilting after harvest	96 hours wilting after harvest	144 hours wilting after harvest	Mean for chopping treatments
Grass chopped to 3 cm length C1	82.94	83.75	80.75	77.47	81.23
Chopped to 10 cm length C2	75.52	79.95	79.96	74.72	77.39
Chopped to 20 cm length C3	72.25	73.72	75.03	69.42	72.73
No chopping C4	61.75	64.69	66.78	62.39	63.90
Mean for wilting treatments	73.24	75.48	75.53	71.00	

Table II

Citral percentage in the oil for the different wilting for chopping and wilting treatments

Treatments	No. wilting	48 hours wilting D2	96 hours wilting D3	144 hours wilting D4	Mean for chopping treatments
Chopped to 3 cm length C1	86.44	88.71	88.81	88.38	88.08
Chopped to 10 cm length C2	85.84	87.11	88.28	87.96	87.30
Chopped to 20 cm length C3	85.71	86.58	88.83	88.52	87.41
No chopping C4	83.07	84.88	87.24	87.14	88.57
Mean for wilting treatments	85.27	86.82	88.29	88.00	

Lemongrass wilted for 48 hours and chopped to 3 cm length prior to distillation is conducive to higher recovery of oil.

In Vetiver, the roots are washed and cleaned of adhering earth and then properly dried in shade. The drying of the roots is very important since in the presence of excessive moisture, unpleasant smelling volatile oils are produced due to chemical decomposition. For citronella the drying can be allowed to continue till the plant material withers. In cinnamon drying the leaves for 48 hours before distillation gives more yield with high eugenol content. The drying of leaves of eucalyptus before distillation has no effect on the yield of oil (Muraleedharan and Nair, 1974).

Salt Water Treatment

Dipping of chopped lemongrass in sodium chloride solution, concentration varying from 0.5 to 2.0% for 24 hours before distillation has given the following results.

Quantity of grass: 1-1/2 kg	Average of 5 distillation oil in cc.	Average of 5 distillation Citral %
1. Control No treatment	6.8	84.18
2. Dipped in 0.5% sol.	6.02	85.82
3. Dipped in 1.0% sol.	5.94	87.78
4. Dipped in 1.5% sol.	6.08	87.64
5. Dipped in 2.0% sol.	6.58	87.66

There is an increase of citral content from 84.18 to 87.66% without much affecting the production of oil when the chopped lemongrass is dipped in 2% sodium chloride solution. This is an important factor which determines the commercial value of the oil.

Cohobation

According to De-silva (1957) the application of the principle of cohobation (injecting the condensate water over the plant material) results in an improved yield of citronella oil. The experiments conducted in the Lemongrass Research Station, Odakkali on lemongrass with and without cohobation in experimental stills in water and steam have given the following results.

15 kg of grass distilled	Average of 28 distillations			
	Oil (cc)	Citral percentage	Specific gravity	Refractive index
With cohobation	35.35	79.63	0.8783	1.4813
Without cohobation	35.21	80.76	0.8794	1.4812

There is no significant increase in the quality and quantity of lemongrass oil when distilled by adopting the principles of cohobation under water and steam condition. Studies are in progress in the station under completely steam conditions.

Distillation under Pressure Steam

The distillation under steam has the added advantage that the ratio of water to oil in the condensate can be changed by altering the operating pressure. In an experiment conducted in the station to study the effect of different pressures on the quality and quantity of oil the following results were obtained.

Treatment pressure (lbs)	Oil from 150 kg of grass (ml)	Citral (%)	Specific gravity	Refractive index
20	540.0	89.5	0.8781	1.4818
15	498.0	89.3	0.8865	1.4814
10	387.5	88.0	0.8720	1.4815
5	440.0	87.3	0.8752	1.4816
F test	N.S.	N.S.	N.S.	N.S.

The mean yield of oil and citral content were higher when the lemongrass was distilled at 20 lbs. pressure (Chandrasekharan, 1974).

Time of Distillation

The time of distillation has been standardized to 1-1/2 hours for lemongrass, motia, and citronella in the station under partly steam conditions. For eucalyptus the time of distillation is 2 hours (Muraleedharan and Nair). For Vetiver it is 36 hours. According to Belcher (1965) the rate of extraction of oil is directly proportional to the condensate flow over the normal range of supply of steam. He has found that the condensate flow of 0.3 lb/hour/lb of clove buds to be economic. The economic condensate flow for the distillation of lemongrass oil is found to be 0.35 kg/hour per kg of the material.

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References

1. Belcher, W.F.M.: Distillation of clove oil. Perfumery and Essential Oil Record Vol.56, No.3, 1965.
2. Chandrasekharan Nair, K.: A study on the effect of steam under different pressures on the distillation of lemongrass. Agrl Res.J. Kerala 12(2), 1974.
3. Chinnamma, N.P. and Menon, P.K.G.: Effect of harvest at different intervals on the grass and oil yield and citral content in lemongrass. Agri.Res.J. Kerala, 11(2), 1973.
4. Chinnamma, N.P. and Menon, P.K.G.: Effect of pre-treatment of lemongrass on the yield and citral content of oil. Agri.Res.J. Kerala, 11(1), 1973.
5. De Silva, M.G.:.Ceylon citronella oil. Soap Perfumery & Cosmetic, Vol.30, No.11, 1957.
6. Guenther, E.: The essential oils. D.Van. Nostrand Company, P.P. 111 New York.
7. Muraleedharan and Nair, E.V.G.: Cultural and manurial requirements of Eucalyptus citriodora in Wynad, Kerala. Indian Perfumer, Vol.18, Part I, 1974.
8. Nair, E.V.G.: Eucalyptus citriodora-cultivation and production of oil. Indian Perfumer, Vol.18, Part I, 1974.
9. Sadagopal: The development of the essential oil industry in India and Pakistan.
10. Sreedharan, A. and Chandrasekharan Nair, K.: Studies on Vetiver in relation to the time of harvest. Agri.Res.J. Kerala, 11(1), 1973.

PRODUCTION OF LIQUID MENTHOL AND CRYSTAL MENTHOL FROM DEMENTHOLISED OIL

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Japanese 'mint oil' yields 40-50% of crystals menthol by chilling and centrifuging. Dementholised oil which is obtained as a a commercial item after separation of crystalline menthol (about 40%) from the oil of Mentha arvensis is used for making cheaper type of flavour compositions and in imparting mentholic note in the inferior types of confectionary items, tooth paste, pan masala and tobacco's. The dementholised oil, contains still most of the ingredients of natural oil. About 50-55% of menthol (in liquid form) along with sufficient quantities of menthone and menthyl acetate are also present and these could be converted into a mixture of liquid and crystalline menthols.

The average composition of natural and dementholised oil determined in our laboratories in numerous samples ranged as below:

	Natural oil	Dementholised oil
Menthol (both liquid and crystal)	70-75%	50-55%
Crystalline Menthol	40-45%	0-5%
Liquid Menthol	30-35%	45-45%
Menthone	8-10%	12-15%
Menthyl acetate	12-15%	20-30%
Terpenes	5-6%	7-10%

The present work deals with utilisation of dementholised oil for getting menthol and liquid menthol from numerous angles.

The work is summarised herewith.

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EXPERIMENTAL

Alcoholic Saponification and Dementholised Oil

Alcoholic saponification of 500 g of dementholised oil was tried with 3 litres of 0.5 N alcoholic sodium hydroxide in 5 lits. flask. The saponification was carried out only for a period of 1.5 hours and afterwards 2.85 lits. alcohol was recovered on the water bath. The residue on washing with alcohol showed a yellow colour and hence hydrodistilled.

During hydrodistillation the first 175 g of the product (A) was kept separately and the second about 250 g (B) was kept separately. The former and latter portions of the oil were separately examined. The former part showed to be a mixture of 50% of terpenes, 45% of menthone and 5% of menthol, while the latter portion showed to be only a mixture of liquid and crystal menthols. The chilling and centrifuging of this part gave 125 g of crystal menthol and 115 g of liquid menthol.

Aqueous Saponification Method

Dementholised oil (500 g) was refluxed with 1.5 lit. of 30% (W/V) of caustic soda for 6 hours. Afterwards the aqueous alkaline layer was rejected and the upper oily layer was separated, thoroughly washed with water and hydrodistilled with 10 lits. of water. During distillation the oil arriving in the initial distillate and comprising 180 ml. of oil (A) was kept separately and the latter portion in which all the amount of oil left behind was collected (240 gm) (B), was kept separately.

The portion A was having a very faint odour of menthol as evidenced by its analysis which showed the presence of 45% of menthone, 45% terpenes and 4% of menthol. The second lot (B) had strong and pronounced odour of menthol. Physiochemical data and thin layer chromatography established this fraction as the mixture of menthol isomers only. Crystal menthol was separated from it by chilling and centrifuging in a yield of 125 g. The balance was recovered as liquid menthol in a yield of 105 g.

Sodium Alcohol Method

Dementholised oil (500 g) was dissolved in 1.5 lits. of aldehyde-free ethanol and 15 g of sodium was added in small pieces so that the hydrogen evolved is consumed completely before further addition of sodium. After whole of the quantity of sodium is added the product is kept overnight. The alcohol was then recovered on a water bath (recovery 2.5 lit) and the residual product distilled with 10 lits. of water. The first portion of distil-

late which gave about 100 ml. of oil (A) was kept separately while the latter portion comprising a total of 330 ml of oil (B) was kept separately.

The portion (A) contained mainly 95% of terpenes and 5% of menthol. Not a trace of menthyl acetate or menthone was detected in it. The portion (B) contained only menthol isomers from which crystal menthol was obtained in a yield of 175 g by chilling and centrifuging. The balance being liquid menthol, was recovered in a yield of 140 g.

Reference

Guenther, E.: The Essential Oils, Vol. III, D. Van Nostrand Company Inc., New York, 1958, p. 674.

DEVELOPMENT OF ESSENTIAL OIL INDUSTRY AS UNDERGROWTH OF FOREST IN INDIA

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President and Members of the Essential Oil Association of India. I come before you to place the great potential of Essential Oil Industry as forest product for the country. Ranjani Palme Dutt in his book 'India Today' remarked that only one and half per cent of the water resources are being utilised and not even one per cent of the economic potential of forest industry.

Today I wish to bring to the notice of the Forest Utilisation Officer here and the technical experts on essential oils that the great potential of developing of essential oil bearing plants as earner of foreign exchange and providing employment to millions, is possible.

Herbert Howard, the eminent forest expert, estimated that in India, there are 3 lakh square miles of idle forest land, which can be utilised for planting of rosha grass and other aromatic crops as forest undergrowth and thus utilising the forest waste land and earning 2.5 crores (and now with the rise of prices more) of foreign exchange in India—a scheme costing 2 to 4 crores of rupees is suggested for the cultivation of 10 lakh acres of forest land with aromatic plants. It is estimated that this will result in employment of 6 lakh people besides earning 5 to 6 crores of rupees as foreign exchange.

Besides this industry would release spent rosha grass 130 quintals per hectare. This even could be utilised for paper pulp which is in great shortage in India.

The above results have been demonstrated in a marshy forest blank, an uneconomical area in Dehradun Reserve Forest, leased to a displaced planter, no less the son of the renowned essential oil pioneer Mr. Pooran Singh, the First Biochemist of the Forest Research Institute (1906 to 1916). This lease area

after 25 years of hard work has been coverted into a modern palmarosa oil plantation industry, the product of which is internationally recognised as a finest product. The results of these years have clearly demonstrated feasibility of the scheme of Mr. Herbert Howard. The yield per hectare is 25 kg and the employment potential of this small area is over one lakh rupees per year and produces export commodity worth one lakh and fifty thousand, thus showing the great potential of essential oil industry as undergrowth of forest blank and failed plantations.

It is brought to the notice of the members present here that we, the experts who have spent years of hard work in developing a useful national industry, are driven to the walls and the fruits of our labour under political and economic pressure are being snatched from us. It is for this reason why the intellectual experts feel frustrated.

DEVELOPMENT OF PEPPERMINT INDUSTRY IN U.P.

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Peppermint, technically known as menthol, is used in a number of products of daily use such as dental preparations, shave lotions, cigarettes, confectionery and pharmaceuticals. Up to 1964 menthol of worth more than one crore of rupees was imported into India. During the last decade, peppermint industry in the country has made a great progress. The country has attained self-sufficiency in menthol. Besides meeting the internal demand, menthol is being exported too.

The figures for export and import of menthol during the last ten years are given in Table 1.

Table 1

	Import		Export	
	Quantity (kgs)	Value (Rs.)	Quantity (kgs)	Value (Rs.)
1965-66	63,389	17,98,065	-	-
1966-67	4,764	3,76,734	-	-
1967-68	78,195	53,00,054	-	-
1968-69	56,774	23,62,363	-	-
1969-70	2,810	1,53,198	35	3,710
1970-71	147	11,059	2,500	18,26,699
1971-72	1,840	1,62,051	6	415
1972-73	1,688	1,61,619	5,900	3,21,689
1973-74	5,683	4,64,679	9,576	13,61,800
1974-75	-	-	17,136	29,04,679

Menthol is obtained from the essential oil of Mentha arvensis (Japanese mint), a plant of Labiateae family. In this oil menthol is present to the extent of 70-85%. After isolating the menthol the oil left behind is known as dementholised oil. This oil contains 50-55% menthol and is as such used in some products such

as dental preparations and confectionary etc. After rectification the oil is used under the name of Mentha oil which has been specified by Indian pharmacopea for medicinal use. Dementholised oil is also a good source of menthol and is used for the production of the latter.

Another source of menthol is peppermint oil which is obtained from Mentha piperita. This oil is specified by British pharmacopea and as such used in pharmaceuticals. It is not used for the production of menthol as it contains less amount of menthol as compared to Japanese mint. Mentha oil obtained by the rectification of de-mentholised oil is also used in place of peppermint oil.

Mentha piperita is not cultivated in India on large scale. The entire consumption of peppermint oil is met by imports. Some quantity of de-mentholised oil is also imported. The figures of imports of peppermint and de-mentholised oils during the last ten years are given in Table 2.

Table 2

	Peppermint oil		De-mentholised oil	
	Quantity (kgs)	Value (Rs.)	Quantity (kgs)	Value (Rs.)
1965-66	81,611	18,00,566	-	-
1966-67	47,655	20,97,530	-	-
1967-68	80,895	41,36,985	-	-
1968-69	1,60,740	68,23,282	-	-
1969-70	1,38,125	54,99,907	-	-
1970-71	1,21,838	45,61,683	-	-
1971-72	1,59,017	86,10,780	-	-
1972-73	53,716	22,16,618	70,601	33,86,396
1973-74	53,399	23,33,206	49,363	33,49,391
1974-75	13,356	13,68,955	25,011	22,86,526

Attempts were made for the cultivation of Mentha piperita in India. But its cultivation could not be economically successful as the yield of the oil per acre was less than half of Mentha arvensis. Secondly, the oil did not meet the specified standards. Hence it could not find market in India. That is why the farmers felt reluctant to undertake its cultivation.

The cultivation of Mentha arvensis has been very successful, particularly in U.P. In this State its commercial cultivation was started in 1964 in Tarai region with the efforts of M/s Richardson Hindustan Ltd., Bombay and M/s Bhavana Chemicals Ltd.,

Baroda, with the technical assistance from CIMPO. The cultivation was extended to Nainital, Rampur and Moradabad districts of U.P.

M/s Richardson Hindustan Ltd., established first distillery for Mentha oil at Bilaspur in Rampur district. M/s Bhavana Chemicals Ltd. distributed small distillation units to cultivators. In 1970 one distillery was established at Sambhal (Distt. Moradabad) and another at Rampur. In 1971 and 1972, two more distilleries were established at Sambhal. In 1974 one more distillery was established there. In 1975 one distillery was set up at Shaharanpur.

In 1971 the cultivation of Mentha arvensis was undertaken in Lucknow, Bara Banki, Gonda, Basti and Baharich districts of U.P. with the efforts of M/s Crystal Chemicals Laboratories, Lucknow, with the assistance of the National Botanic Gardens. The above concern gave all types of incentives to the farmers of this area and distributed small distillation units to the cultivators.

Now the plant is well established in U.P. and presently about 6,000 acres of land in the State are under this crop. About 10 big distillers and a number of small distillation units are operating in U.P. and about 200 tons of the oil are produced annually. The main centres of the cultivation are Kashipur, Haldwani, Kichcha in Nainital District, Sambhal, Chanausi in Moradabad district, Ujhani, Bisoli and Asafpur in Badaun district, Balrampur and Mankapur in Gonda district and areas near Bara Banki, Baharich and Saharanpur.

Production of Menthol

Besides,cultivation and distillation of Mentha arvensis, the State has gone ahead with the production of menthol also. Richardson Hindustan Ltd. and Bhavana Chemicals Ltd. procure the mentha oil from U.P. and process it at their units at Bombay and Baroda respectively. In U.P., for the first time, the isolation of menthol was started by M/s Brij Bhushan Lal Gupta & Co. at Saharanpur in the year 1962. He was producing menthol on very small scale. After this in 1971 the processing units were established by M/s Lalji Kedar Nath Khatri and M/s Crystal Chemical Laboratories at Lucknow and by M/s Raj Narayan Ram Narayan and M/s Ram Narayan Pratap Narayan at Kannauj.

In 1972, the National Botanic Gardens, Lucknow, initiated a programme of extending practical training in the production of essential oils and isolates to the representatives of private industries. Under this programme seven parties had obtained the

training in the production of menthol. Out of them two parties (M/s Mentha Allied Products and M/s Orgo-metic Chemicals) had established their processing units at Sambhal, District Moradabad, and one (M/s Denesh Jain Industries) at Lucknow. In 1973, two units, one (M/s Essential Oil Isolates) at Bareilly and the other (M/s Mankapur Chemicals Pvt. Ltd.) at Lucknow came into being.

At present 10-12 manufacturing units are working in U.P. and about 25 to 30 tons of menthol is produced annually.

FLOWER PERFUMES - PRESENT POSITION OF PRODUCTION IN INDIA AND ITS FUTURE SCOPE

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The manufacture of essential oils and perfumes has been carried out in India since times immemorial. Indian perfumes products such as attars, perfumed waters etc. were known throughout the world for their quality, aroma and lasting effect. Now the industry in India has lagged behind as the perfumers in India have not adapted to the modern scientific and technological advancement in the field of perfumery. They are sticking to the age old traditional perfume products, which have a limited market these days.

Essential oils and perfumes of worth about 2 to 3 crores are imported every year in India for the use in several consumer goods like soaps, cosmetics, perfumes and detergents etc. The figures of the imports of essential oils during the last 5 years are given in Table 1.

Table 1

Year	Value (Rs.)
1970-71	1,63,24,857
1971-72	2,22,23,185
1972-73	2,29,41,353
1973-74	3,09,52,808
1974-75	2,68,59,392

India also exports essential oils and other perfume products of about 4 or 5 crores annually. In 1975 the export value had gone as high as Rs 9 crores. The figures of the export of these commodities during the last 5 years are reported below in Table 2.

Table 2

Year	Value (Rs.)
1970-71	3,80,61,647
1971-72	3,92,57,686
1972-73	4.08,04,615
1973-74	6,28,53,956
1974-75	9,32,87,604

Flower perfumes command a dominating position among the perfumes used now-a-days. These are incomparable and at present inimitable by synthesis. Flower perfumes cost very high and are used in high grade perfume, cosmetic and toilet preparations. Out of the total import of the essential oils and perfumes, these perfumes val ue 8 to 10 lakhs of rupees annually. In 1975 the import figure for these perfumes was 52 lakhs of rupees.

The major consumer of the flower perfumes is cosmetic industry which demands these perfumes in natural form. As this industry is expanding more and more, there exists a continuous and ever increasing demand for these perfumes. So these perfumes have great export potential.

Indian flower perfume products such as attars, hair oils and perfumed waters etc. are not used by the cosmetic industry. That is why they have a limited market. However, these perfume products have a good market in middle east countries, where these are very popular. Export figures of these perfumes during the last 5 years are given below in Table 3.

The most common flower perfumes are obtained from the flowers of rose and jasmine. Both the perfumes find extensive use in perfumery and are used almost in every high-class perfume formulations.

Rose. The commercial scented variety of rose used for rose oil production in Rosa damascena commonly known as chaiti or fasli gulab in India. The plant is cultivated in Bulgaria, Italy, Turkey, Morocco and U.S.S.R. on commercial scale. In India it is grown at Barwana, Hissayan in Aligarh district and Sikenderpur in Ballia district. Recently its cultivation has been undertaken at Ram Nagar in Bara Banki district.

There is another scented variety of rose, Rosa bourborica or Edverd rose, which is commercially cultivated in India at Chingelput, Tanjore, Trichnapalli and Madurai districts of Tamil Nadu. It is also cultivated in Rajasthan and Madhya Pradesh.

Table 3

Perfume Product	Value (in rupees)				
	1970-71	1971-72	1972-73	1973-74	1974-75
Kaora oil	70,534	1,85,681	54,000	1,06,251	13,000
Attars	25,425	13,702	21,631	31,234	1,37,911
Hair oils	20,94,183	17,92,299	23,37,854	33,30,088	61,55,954
Rose water	1,43,015	1,22,296	1,39,366	1,48,893	2,48,036
Perfumed Aquous distillates	4,68,651	3,49,956	6,57,310	3,45,320	5,25,721

The products made from rose flowers in India are rose water, rose attar, Gulkand and small quantities of rose-otto or oil. Rose oil is not distilled commercially. Whatever quantity of it is available is obtained as a bye-product of rose water industry.

Jasmine. There are several species of Jasminum growing in different parts of India. The flowers of the plants are mainly used for making garlands, chaplets, decoration bunches and for religious offerings. From the point of perfumery the commercially important variety of jasmine is Jasminum grandiflorus known as chameli in Hindi. The flowers of this plant are used for the preparation of perfume concentrates (concrete and absolute) in France. It is cultivated on large scale in France, Italy, Syria, Algeria and Morocco. In India it is cultivated at Ghazipur, Jaunpur, Ballia and Furrukabad in U.P. Recently its cultivation has been undertaken in Tamil Nadu under a scheme of the Indian Institute of Foreign Trade. About 1200 hectares of land in that State is under the cultivation of this plant.

In India, jasmine flowers are used for the preparation of jasmine hair oil. The oil is based in sesame-seed oil. Besides J. grandiflorum, there are other scented species of jasmine which are cultivated in India for perfumery purpose. These include the varieties of J. sambac, viz. J. sambac Palampur (Gujrati bela), J. sambac Madan Man (Bela), J. sambac Motia and J. sambac Mogra. The flowers of these plants are used for making attars and perfumed oils.

The third important perfume produced in India is Kaora which is obtained from the flowers of Pandanus odoratissimus. The

perfume is contained in the spathes of its male flowers. The plant grows wild in many parts of India, but commercially it is exploited at Kallapali, Meghna,Agrame in Ganjam district of Orissa and a few centres in U.P. and Tamil Nadu.

Its flowers are mainly used for making Kaora water and Kewda attar. The Kaora oil or otto as it is called is not the pure oil, but based in the palmarosa oil.

India has a long tradition in growing the fragrant flowers but lagging behind in the modern technology of perfumery. Indian perfumers are using the remote techniques for extracting perfumes from flowers which are unscientific and uneconomical. A brief of the methods used is given below.

1. Distillation. The flowers are distilled with water and the distillate is collected over sandal wood oil or liquid paraffin or palmarosa oil for the preparation of attars. Perfumed waters are also prepared by the distillation. This technique is applied for the processing of rose and kewda flowers.

2. Digestion of flowers with sesame seeds and subsequent expression.

This technique is applied for processing the jasmine flowers to obtain perfumed oils. The flowers are put in the layers of sesame seeds. The odour emitted by the flowers is absorbed by the seeds. On getting the seeds saturated with the fragrance, these are expressed in expeller to obtain the perfumed oil.

By the techniques mentioned above, only attars and perfumed oils can be prepared which are mixtures. Perfume and cosmetic industry demands pure perfumes in natural form. Natural perfume extracts are obtained by solvent extraction of flowers now-a-days.

The flowers are extracted with suitable solvent purified to perfumery grade. Light boiling petroleum ether is generally used as solvent. From the extract the solvent is distilled off. The residue left behind is known as concrete and is crude extract of perfumes from flowers. This concrete is used as such in many perfume formulations and also for the preparation of absolutes. For preparing the absolutes the concrete is dissolved in alcohol (perfumery grade). The alcoholic solution of concrete is chilled. The waxes get crystallised. These are removed by filtration. The filtrate is distilled at low pressure to remove alcohol. The residue left behind is known as absolute which is a very concentrated extract of perfume.

The perfumers abroad have their own techniques for the preparation of absolutes. However, they buy concretes for their utilization. Concretes are also the source of spiritous perfumes, which are very popular in modern society now-a-days. Concretes and absolutes are very costly perfumes. The price of concrete from rose and jasmine flowers fluctuates between Rs 2500 to Rs 3000 per kilogramme. Concrete from any scented flower will have its value in perfumery market, provided its regular supply is guaranteed to the consumers.

India has diversity of climate and its flora abounds in scented flowers. Some of them are cultivated and some grow wild. Besides, the flowers mentioned above, the following flowers may be utilized for concrete production:

Rosa centifolia, Rosa alba, Rosa muscata, Rosa indica (Edverd), Jaminum sambac varieties (other than mentioned above), J. auriculatum, J. arborescens, Tegetus erecta, Anthocephalus cadamba, Mimusops elengi, Nyctanthus arbortristis, Cestrum nocturnum, Polianthus tuberosa, Lawsonia inermis, Narcissus spes. etc.

All these plants are grown in Indian gardens. Besides, there are a number of other scented flowers growing wild which can be utilized, such as Acassia furnaciana, A. arabica, Cassia fistula, Michelia champaka, Muraya exotica, M. peniculata and Musaferra etc.

The above studies reveal that there is very good scope of production of concretes from flowers in India. There is no dearth of raw material, technique is also quite simple and can be easily worked out under the Indian conditions. Besides, the concentrates have good export potential and can promote the foreign trade of the country in perfumes to a great extent. In the interest of the perfume industry in India, perfumers should look into the possibilities of concretes production from flowers. Its planning should be done with the cooperation of Government and agriculturists.

References

1. Anonymous: Development of essential oil industry in U.P., (1954), H.B.T.I., Kanpur. P.7-9.
2. Anonymous: Monthly statistics of the Foreign Trade of India (Imports & Exports), Govt. of India, Department of Commercial Intelligence and Statistics. March 1971, 1972, 1973, 1974, 1975.
3. Muthuswami, S and Madhava Rao, V.N.: Essential oil of Jasmine flowers. Indian Perfumer, Vol. 18, Pt.I (1974), P.31-34.

4. Goldstein, C.: Manufacture of concretes and absolutes from Indian flowers, Essential oil and Aromatic chemicals (A. symposium) (1958), C.S.I.R., New Delhi, P. 7-9.
5. Arctander Steffen: Perfume and Flavour Materials of Natural Origin (1960), Elizabeth N. J. (U.S.A.), P. 309-313.
6. Anonymous: The Wealth of India, Vol. V (H.R.) (1959), C.S.I.R., New Delhi, P. 279-292.

PRODUCTION TRADE AND QUALITY CONTROL IN SOME ESSENTIAL OIL BEARING SEEDS/FRUITS OF INDIA

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Introduction

The historical records show that the cultivation of many economic species was taken up on Government and private level in different climatic conditions so as to conserve the vegetable resources. There are descriptions in early scientific accomplishments in Ayurveda as *Vedas* and works of *Charak*, *Susruta*, wherein numerous types of plant materials has been listed along with the techniques of distilling flavours and some of these works date back 4000 B.C. From the legendary documents of *Persians* and *Egyptians* also, it is observed that they were extracting essential oils for making perfumes, to purify the environment, for flavouring dishes, scenting edible items, etc. using them in cosmetic products and many other purposes. During the past few centuries, oriental flavouring plant material was highly prized for making use as perfumes, in cosmetics and sanitary purposes. Many distilled products as rose water etc. were also employed for medicinal purposes in burning sensation of the eyes. Famous traveller Fahein has described India as the land of aromatic flowers, fruits, seeds, woods, roots, resins and grasses. Indian trade on essential oil was at its peak before the Moghal came and the price of many items used to be judged on the basis of essential oil per ounce. Indian cities like Lucknow, Ghazipur, Kanauj, Jaunpur etc. were known for their quality 'Attars' in Europe and Africa.

About five centuries back many forms of essential oil have come into Unani system of medicine for treating various human ailments. From 1850-1891 several works on essential oil have come up and in 1891 for the first time *Bornemann* emphasized the botanical identity of volatile oil forming parts of the species. The dictionary of essential oils (1916) describing alphabetical list of 1268 species, presented in the journal of perfumery may be mentioned. In this paper a list of 20 species is presented on the same pattern as has been described in the above work (1916) along with the type of climate

discussed in (Agarwal 1973) paper on raw material for spice,from where best quality specimens have been obtained. *Chopra* et al (1956), Wealth of India (Raw materials and industrial products) upto 1972 have further listed about 100 more species in the list of raw materials exploited for essential oil purposes. Studies reveal that the fruits/seeds of about 80 species are employed for extracting essential oil. Presently essential oil has taken up a prominent part in our day today life and it is now difficult to think anything without an essential oil which goes in automobile industry (for enamelling, lubricants, polishes, etc.), baked/unbaked food industry. (Cakes, meat, puddings, confectionary items etc.), canning industry (jellies, jams, chewingum, toffees, etc.), condiments; dental preparations of pastes, mouth wash etc.; insecticides; cosmetic industry; pharmaceutical preparations as (laxatives, ointments, etc.); domestic products as deodorants; paper industry in making carbons, ribbons, tapes, etc.; petroleum industry (solvents, waxes, etc.); rubber industry (gloves, toys, etc.); drinks; textile and tobacco and many other diversified industries.

Production

Although the fruits do not form officinale so far as the essential oil is concerned in India but afford a great future. The citrus oil extracted from fruit skin has gathered tremendous momentum in the international field and in this context, exploitation of such fruits for the production of quality material will give greater opportunity of export. Italy produced about 8 lakh kg of lemon oil from the fruit peels on an average per year for the last one decade wherein 80% of the total fruits were used up as food and the remaining 20% in the canning industry. The canning industry was disciplined to remove the skin carefully and supply the skin to the essenntial oil mill, an adjunct to such industries. For economic working of any establishment, it is essential to exploit properly raw material. In India production of citrus fruits is many times to that of Italy but that of the oil is hardly half of it.

Similarly *Glycine soja* Sieb & Zucc., oil possesses low coles-trol value and highly useful for human health. Its oil is employed mainly as an article of food. Quite a good number of states have picked up its cultivation as throughout Eastern region of India, Kashmir, Punjab, South India, Bihar, U.P. etc. and the estimated crop of the seeds in 1948-49 was about 1100 metric tons which appears to have decreased in 1960 to about 800 metric tons. Very recently more area has been earmarked for its cultivation and has just crossed 1948 limits. Because of its unpopular demand, neither its oil nor its seeds have come into prominence in India. USA has been the largest producer of Soyabeans to the tune of about one crore metric tons and exporting more than 2/3 of its seed oil as seen from the international trade records (1974-75). Glycine oil possesses

very bright future especially when discouraging reports of adverse efforts on health are available in respect of other edible fatty oils.

Foeniculum popularly known as 'saunf' in Indian trade is another fruit worth mentioning here. Fennel fruit oil is manufactured in small scale concerns, and possesses great scope in the international market being the only refrigerant oil available from seeds/fruits in the whole world. Indian production ranges from 620 kg/hectare to 700 kg under natural conditions but if proper manuring is given, the production may increase to about 1200 kg/hectare. Practically all states grow in small/big areas, this species. 90% of the crop is eaten up by Indians as a condiment or raw, while the rest is employed for extracting oil.

From the latest statistics as are available in the international trade journal (1973-74) it is observed that *Madagascar* and some European countries produce about Rs 23 lakh of clove oil, USSR-USA combined give about 1 crore rupees worth of citrus oil and Rs 80 lakh of coriandrum by USA and Europe. The over-all production of raw material in India is greater except in cloves, than the places where such oils are being manufactured. India produces upto 10 kg of fruit buds in dry weight per plant of cloves and is no less than the average production of cloves/tree in *Zingibar*, the best clove producing region of the world. The percentage of oil extraction in India has shown an upward trend and in some types of cloves, about 18% oil has been extracted. Each state is producing coriander of commerce and the yield of the crop in India has been very encouraging and ranges from 1200 kg/hectare to about 2450 kg/hectare when sown as pure crop. In Maharashtra alone 750 hactre of land has been earmarked for coriander cultivation. Since these fruits are used as condiment, the available quantity for oil extraction is too little. The scope of exploiting coriander for oil purposes is slightly greater, if the 20% wastage in its collection, decay and in handling, packaging etc, can be avoided. The use of mechanized system probably will advance greater hope of protecting wastage, finally accelerating the export of finished products, as essential oil from the surplus raw material.

Cymbopogon martini (Roxb.) Wats is another crop in India which has been quite popular in Hyderabad, U.P., Tamil Nadu, Bengal and Punjab. Only at Tamil Nadu and Punjab, on a small scale, the seeds are employed for extracting oil. A good crop may give about 24 kg of fruits/hectare and has not been considered as a profitable venture. Therefore the whole crop, from rhizome to foliage, fruit and flowers are put to commercial exploitation for oil. Its fruit oil has opened new avenues as it is very useful in pharmaceutical industry, the selection of proper material by undertaking selective sieving through mechanical sorters will further enhance the international value of martini oil.

Carum carvi L. commonly called as *'Zira siah'* is equally important from unani, ayruvedic system of medicine. Certain allopathic preparations employed for curing cold effects, use carvi oil. Its oil has a great demand in the foreign market. From its trade, it is observed that India imports substantial quantity of caraway seeds and mostly eaten as condiment. Indian cultivation on hilly areas is very little and its yield ranges 7 to 9 tons per hectare of land whereas in Holland 24 tons per hectare are produced on an average. If,however, efforts are made to grow good variety of seeds with proper manuring, it is not improbable to get the yield at par with international record of produce of these seeds/fruits.

Cardamums big and small are grown abundantly throughout Nepal, West Bengal, Assam and South India, Western ghats, Bengal respectively but their quality seeds/fruits are not very common. During 1970 records about 3000 metric tons of small cardamums were produced and about 1/4 of this yield gave quality material whereas big Cardamums were produced 3 to 4 times of the small ones. Their oil is very valuable for many industries but quality oil is in want to increase the exports. Ajmud *(Apium graveloens)* gives salad oil of commerce and has been considered important for canning, confectionery and cosmetic industries. Its produce on Indian soil has not been very encouraging and has been recorded from 15 to 24 kg of seeds/hectare of land. Indian peppers are very important from international point of view since the country produces some of the best peppers of the world. Although 20 forms of peppers are available in India out of which only one form is good for extracting essential oil as described under quality control of raw materials. India gives about 30,000 tons of pepper in dry condition from South India and Western India but Indonesia tops in production by 15,000 tons more than India and exports 2/3 of this quality. Its oil has been prized for the existence of a good number of industries like pharmaceutical, confectionery, cosmetics, canning, automobile, etc.

Eucalyptus and Myristica oil are also important. The oil from former plant is of mixed variety where seeds, leaves etc. are employed together to get the eucalyptus oil for use in cosmetics, medicines etc., but at very few places in Mysore, fruit oil is also produced which has a great demand in foreign market. About 25,000 kg of eucalyptus oil is extracted in India. Myristica or nutmeg oil has been considered very good in certain life saving drugs. Indian trees give fruits up to 80 years of age of a tree and may produce from 4000 to 20,000 fruits/tree per year, 6-16% oil is extracted from its fruits. In Indonesia three crops are taken out every year but in this country only one crop is produced. It may prove helpful if mitochondrial acceleration is effected so as to produce such fruits which can give early fruiting and more crops may be harvested per year from the country.

Trade: Indian trade to foreign countries before the world war I, was very discouraging. Only 240 tons of essential oil was exported chiefly to U.K. and some other European countries but about Rs 10 lakh worth of essential oil from the group of species enlisted in this paper were brought to India from U.K. and Australia, Singapore, etc. Raw materials of essential oil producing seeds/fruits were sufficiently exported and seeds to the tune of about Rs 38 lakh and spices which also yield essential oil worth Rs 68 lakh were exported from India chiefly to Commonwealth, American, European countries. From the latest statistics given in the following list, it will be observed that there has been a decline in the imports of essential oil substantially and exports have been accelerated. If quality material is produced, it is plausible to think, that Indian material will top the list of international requirements so far as essential oil is concerned. It is hoped that there would be further attempts to stop the flow of such raw material which is used in foreign countries for extracting oil and only seeds for condiments should be thought for exports.

Import and Export of essential oil/seeds/fruits during 1974-75 ending in March 1975

Imports

S.N.	Common name of seeds/ fruits or essential oil	Countries from where imported	Quantity
1.	Glycine seeds	Australia and USA	18,05,332 kg worth Rs 1,12,000
2.	Pepper	Nepal, Indonesia	22,776 kg worth Rs 1 lakh
3.	Piper	Burma and Indonesia	1,086 kg worth Rs.50,000
4.	Clove oil	China, Madagascar, Indonesia and Singapore	12,000 kg worth Rs 6 lakh
5.	Clove heads	China and Singapore	3,482 kg worth Rs.90,000
6.	Nutmegs	China, Indonesia, Singapore, E. Africa	34,000 kg worth Rs 9 lakh
7.	Big Amomum	Nepal	11,000 kg worth Rs 4 lakh
8.	Small amomum	Indonesia, Bangladesh	1,000 kg worth Rs 40,000

9.	Coriander seeds	Nepal	36,000 kg worth Rs. 92,000
10.	Misc. essential oil from seeds and fruits	Germany, Indonesia, Iran, Nepal and Singapore	85,000 kg worth Rs 14 lakh
11.	Cumin black	Afghanistan	2 lakh kg worth Rs 18 lakh
	Exports		
1.	Citrus fruits	Bangladesh, Nepal, Tanzania, Dubai, Afghanistan, Muscat	13,000 kg worth Rs. 46,000
2.	Pepper seeds	Arab countries, Bangladesh, Nepal, African countries, Canada, U.K.	4 lakh kg worth Rs 45 lakh
3.	Long pepper	China, Canada, U.K., Australia, USA, Africa and some countries of Europe	2,25,oo kg worth Rs 3.4 crore
4.	Cardamum (large)	Canada, Afghanistan Australia, Arabs	25,000 kg worth Rs. 2,50,000
5.	Cardamum (small)	USA, UAR, USSR & UK	13 lakh kg worth Rs 1 crore
6.	Coriander seeds/oil	China, Australia, Canada, Arab, Africa, USA, UK	6,50,000 kg wor Rs 27 lakh
7.	Cumins	Australia, China, Africa, Japan, some parts of Europe, UK and USA	14 lakh kg worth Rs 1 crore
8.	Fennel and its oil	Australia, parts of Europe, Japan, Africa, UK, USA	5,53,000 kg wor Rs 39,50,000
9.	Fengreuck	Africa, Australia, Arab, UK and USA	13 lakh kg worth Rs 1 crore
10.	Misc. oil,essential oil from seeds and fruits	UK, USA, Australia, Africa	90 lakh kg worth Rs 4 crore

11.	Ajowan seeds/oil	New Zealand, Hong Kong, Canada, Africa	1 lakh kg worth Rs 3 lakh
12.	Glycine seeds	Europe, Africa	2 lakh kg worth Rs 5 lakh.

The trade statistics have been presented here to show that the avoidable imports can still be reduced more especially of finished products. The Indian finished products for which the country is in a position to produce better raw materials than as is available in the international field should be popularized and their production should be accelerated.

Quality control

The quality (Table) of essential oil bearing seeds/fruits is very important if proper degree of oil properties has to be maintained. In view of the studies made by the author, it is felt that the climate from where the fruits are to be selected is equally indispensable so far as the oils' specific gravity and percentage yield is concerned. The following table will show as to how the agroclimatic conditions are important for getting quality material since the best seeds/fruits have been obtained from such regions discussed in the last column of the table (Agarwal 1973).

Here in the table, it has been shown that among all the areas where a species is grown, the best ones were found from such regions only whose agroclimate has been mentioned. From all seeds/fruits examined obtained from different regions of the country, only those obtained from the listed soil/climatic conditions gave quality raw material.

The descriptions of each species along with some more important characters of seeds/fruits have been listed here, which are considered qualitatively superior or inferior after conducting maceration experiments. In this experiment, measured quantity of each material was selected from one agroclimatic condition and macerated in ethereal liquid. After complete homogenous mixture is is prepared, the mixture is poured on white filter paper and allowed to dry. The oily spot so produced is examined if it is deep or superficial and the degree of relative smell was also studied. The deep spot depicts greater percentage of oil and stronger aroma, a quality product.

Enumeration of the species

Amomum cardamomum L. The good quality fruits are about 3 cm long with 1 cm in diameter at the middle of the elliptical body of the fruit with seed/pericarp ratio 2.5 gm/.5 gm. These are

the best for extracting essential oil since the maceration experiments with seeds showed greater aroma left after the ethereal liquid evaporated. If fruits with seed/pericarp ratio 1 gm/1.5 gm are taken up, the percentage of oil may remain the same but with less aroma and thus a degraded quality.

Apium graveolens L. The good seeds are .2 to .3 cm in length. The fruits are conical and at the narrow end a kind of hood is present. There are 4 to 6 ridges, hairy in nature in longitudinal direction. The whole surface of the fruits is rough having one groove longitudinally. The seeds having no groove and smooth surface showed less aromatic oil after conducting maceration experiments. The macerated paste of such seeds in measured quantity in ether were spread over filter paper. After the ether was evaporated, the relative aroma was examined and the relative degree of oil spot also was observed. It is found in the case of these seeds that oil percentage also will decrease with such poor quality seeds.

Carum carvi L. The plant although is native of Europe, North Africa but grows well in India. The fruits are greyish black with roughly furrowed surface with a boat shaped sickle type dark colour groove. The seeds are .2 to .3 cm in length although bigger than .3 cm upto .5 cm seeds are available, which do not produce good aromatic oil. Oil extracted from smaller fruits is of high order and possesses potential therapeutic properties.

Cariandrum sativum L. Those fruits which are .4 to .5 cm in length, dumble shaped with many longitudinal fine ridges forms good quality material for the essential oil. Those which are .2 to .3 cm in diameter, are highly aromatic. Maceration experiments have shown that seeds with .2 cm to .3 cm long and .15 cm in diameter, smaller forms, greenish in colour (darker from the bigger variety) possess lesser aroma and thus degraded essential oil.

Citrus. About 16 species of Citrus have been reported from the world but due to hybridisation and other treatments numerous forms of the genera have come up. Practically half of the citrus species recorded from the world, are grown in India with their innumerable forms. The essential oil is extracted from the rind of the fruits. Lemon (*Citrus limonium* L.) gives the best percentage of oil with greater aroma. The oil is concentrated in oil sacs of the fruit rind surrounded by vesicles from 0.4 to 0.6 mm in diameter. Lemon contains greater number of such vesicles/unit area. On maturation degraded tissues cover the vesicles which absorb and store the aromatic oil. It is this tissue in the peel which forms an important raw material. If canning industry is directed to supply such rind of fruits, the quality of the oil will imporve. Lemon weighing 100/120 gms each having 50/60 gms of rind thick in nature may produce about 1 gm of good aromatic oil.

Cuminum cyminum L. The fruits are about .4 to .7 cm long having longitudinal ridges, alternated with light colour furrows, 1 mm thick in diameter at the middle part of the elliptical fruits. Good quality seeds are brownish in colour whereas degraded quality seeds are dark coloured having not very clear distinction in furrows and ridges if observed externally without the help of any instrument. The maceration experiments showed greater aroma in respect of light colour fruits.

Cymbopogon martini (Roxb.) Wats. - Its fruit oil is closely related to *C. caesius* Stapf although botanically species are different. *C. martini* has not been grown on a commercial scale. It has two chief varieties, one having white flowers and the other with pink flowers. Seeds from the white flowered plant gave better type of aroma and greater degree of oil spot on the soaking paper by conducting macerating experiments. Such fruits are .7 to 1 cm long elliptical with longitudinal ridges all round and hairs. The poor quality fruits are from pink flowered plants and do not have long hairs over the fruits.

Elettaria cardamomum Maton. Fruits of numerous cultivars of this species are available in India. Those 1 cm long with 0.5 cm in diameter, greenish brown in colour, slightly rounded at the base joining the stalk are good for extracting essential oil. Longer varieties about 1.5 cm long greenish cream colour forms may give greater percentage of oil as observed from maceration experiments but have less aroma. Such large varieties are good as condiment and flavouring dishes mildly but for quality produce of essential oil, smaller, dark coloured fruits are good.

Eucalyptus globulus Labill. The best quality of fruits which can give good percentage of quality essential oil are produced on plants having foliage variations as well. Leaves without the petiole are about 14.5 cm long, whitish blue, I cm broad at the base joining petiole, widening upto 3 cm and gradually down to 0.5 cm at the apex, fruits from such plants are 3.5 cm long without the cap and when cap is intact with the fruits, they are 5 cm long and 2.8 cm in diameter at the junction of the fruit sac and the cap. Fruits picked up just before maturation, showed better oil spots in maceration experiments than the matured ones without caps. Such fruits produce better aromatic oil and it can also give economically positive results. Other forms having foliage about 5 cm broad at the base tapering to 1 cm towards apex, 10 cm long produce low quality fruits; the percentage of oil extracted from this quality fruits appears to show discouraging results on the basis of maceration experiments.

Foeniculum vulgare Mills. Fruits of fennel which are about .8 to .9 cm long slightly sickle shaped .3 to .5 cm in diameter, light green in colour having prominent ridges, gives about 2 to 3% oil

having fine aroma. Those fennel seeds which are smaller in size, darker in colour having fine ridges showed poor aroma on conducting maceration experiments.

Glycine soja Sieb & Zucc. Parabolic seeds, 1 cm long and .5 to .6 cm wide from the middle, produce good percentage of oil as was observed from the spot on a filter paper after conducting maceration experiments. Such seeds are light green in colour. Longer and bigger seeds showed poor results after they were subjected to such maceration experiments.

Myristica fragrans Houtt. 1.5 to 2 cm long, 1.5 cm in diameter with reddish green calyx covering half of the fruits, brownish colour berries constitute the good quality raw material for extracting essential oil. Maceration experiments showed better aroma with such fruits than the smaller fruits. Such good quality fruit weigh about 10 to 15 gm while the inferior ones are of 6 to 8 gm each.

Nigella sativa L. - Good quality seeds produce about .35 to .5% of oil highly aromatic in nature and exhibits beautiful blue flourescence. Such seeds are jet black in colour, about 0.4 to 0.5 cm long with oblong structure, about 0.3 cm at the broader end and about 0.1 cm in diameter at the narrower end. These are slightly laterally compressed. Slightly immature seeds showed positive results on conducting maceration experiments than the ripe seeds which increases in hard pericarp tissues in greater percentage. Some uncompressed seeds grown in certain regions of North India may prove as a good condiment but due to less aroma, give poor quality essential oil.

Ocimum sanctum L. Mixed fruits and leaves are employed for extracting Tulsi oil on a smaller scale but in certain regions of Eastern India, fruits are employed exclusively for extracting quality essential oil, used in pharmaceutical industry. Fruits in .3 to .4 cm long capsules with pin head ridges and reticulated pericarp, dark-green to reddish green in colour with 2 short and 2 long spines give quality raw material for extracting essential oil. Smooth surface capsules having 4 identical spines showed poor aroma on conducting maceration experiments than the former type of Tulsi fruits.

Piper longum L. In India long peppers have not been taken up on a commercial scale but scattered cultivation of the species exists. Since 1965 quite a good number of trees have been planted in Bengal, Assam and North India. About 1 cm long fruits with numerous ridged reticulation and about .5 cm in diameter, reddish brown fruits form the good quality raw material. Maceration experiment has shown better dark olly spot over a blotting paper than longer peppers more than 1.5 cm long which possess high therapeutic values than the essential oil content.

Piper nigrum L. Black peppers in India are available in numerous forms. Fruits born on 10 to 15 cm long spikes having dull green 50-60 berries becoming red on ripening, have been found to form good quality raw material than fully matured blackish berries having thick fruit wall after conducting maceration experiments. Good pepper fruits have very small ridges over it.

Syzygium aromaticum (L.) Merr & Perry. The clove oil of commerce is very important in trade circles. It is exploited in large number of industries. Normally fruits buds in 10-15 clusters, 2 cm with delicate pink colour calyx and reddish head, forms good quality material. The deep red coloured buds are good as condiment but not for extracting oil since they possess less aroma as observed from maceration experiments. The best cloves have a ratio of 3:2 between stalk and flower head.

Thea sinensis L. 1 cm long seeds are good for extracting oil, but the smaller seeds light green in colour, flat on one side constitute poor quality raw material. Good seeds are brownish and almost roundish in shape as is observed after conducting maceration experiments. The percentage yield of oil may be the same but in aroma, they differ.

Trachyspermum ammi (L.) Sprague. The quality seeds are .1 to .2 cm long, conical with raised ridges and grooved furrows, rough surface. The broader end of the fruits is about .15 to .2 cm wide and a slit connects the two cotyledons. The maceration experiments showed greater aroma in smaller seeds than bigger ones ranging .4 cm long .2 cm wide at one end and slightly smooth surface which may be employed as condiment.

Trigonella foenum graceum L. Fengrueck is a common condiment in Indian dishes and good number of agricultural varieties are available in the market samples. .3 to .5 cm long with about .2 cm width, dark green in colour having smoothly depressed seed on one side constitutes good raw material. Light green to pale green seeds of smaller dimensions (.2 to .3 cm) showed relatively less oily spot over the filter paper after the maceration experiment.

Conclusion

With the advancement in the oil technology in the field of percentage extraction, much progress has yet to be made in the selection of raw materials. The qualitative value of such materials is directly proportional to the grade of the essential oil. In this paper author's experimental/observational results have been tabulated in respect of 20 species of fruits/seeds, which are subjected for oil experiments to determine their relative quality only and not percentage. It is further observed that climate plays an indirect role in establishing the quality of a particular seed and therefore should not be neglected. It is

quite important to record not only the percentage yield of an essential oil but also its quality often based on its specific gravity and aroma.

References

1. Agarwal, V.S. 1973. Raw materials for Indian spice industry. Bull. Ind. Mus. 8(2); Calcutta.

2. Anonymous 1916. A dictionary of essential oils, perfumery and essential oil record 7(6); London.

3. Anonymous 1975. Statistics of foreign trade in India. Jour. Com. Intell. & Ind. 1-2(3), Calcutta.

4. Anonymous 1973-74. International trade journal. London.

5. Anonymous 1948-72. Wealth of India (Raw materials) 1-8. CSIR, New Delhi.

6. Anonymous 1958. Symposium of Essential oil and aromatic chemicals, CSIR, New Delhi.

7. Bornemann, E. 1891. Plant perfumes. London.

8. Chopra, R.N. et al. 1956. Glossory of Indian medicinal plants, CSIR; New Delhi.

9. Hooker, J.D. 1872-1897. Flora of British India 1-7, London.

10. Watt. George 1885-1893. Dictionary of Economic products of India. 1-6, Calcutta.

Climate/yield ratio of quality in essential oil producing seeds/fruits. The climate under which the species have been found to give best quality fruits has been mentioned here (Agarwal-1973)

Botanical name	Country of origin	Vernacular name	% yield and colour	Sp. gravity	Climate/soil conditions
1	2	3	4	5	6
Amomum cardamomum	Siam	Bari Illaichi	2.4% light greenish	.9	Swampy places in West Bengal, Nepal, Sikkim, Assam.
Apium graveolens	Europe	Celery	2.3 to 5% slightly colourless turbid	.87	Cool moist climate in silty loams
Carum carvi	Europe	Zira siah	4 to 7% light brown or pale yellow	.92	Temperate regions in Kashmir, Kumaon as summer crop.
Coriandrum sativum	Europe	Dhania	.4 to 1% pale green	.87	Dry loams often irrigated as winter crop.
Citrus limonium	Sicily	Lemon fruit skin	1.7 to 4% light yellowish	.915	Dry lands having occasional rains as winter crop.
Cuminum cyminum	Malta, E. Indies & Persia, North America	Zira safed (cumin)	.7% green colour	.89	In dry lands of U. P. and Punjab on loamy soil with intermittent water.
Cymbopogon martini	India and West Indies	Palmarasa grass	1.5% colourless	.88	Cold climate crop from M. P., Central India, A. P., Maharashtra, etc.
Elettaria cardamomum	South India Ceylon	Choti Illaichi	4 to 8% almost colourless	.92	Between temperature range of 15°c to 35°c and rainfall 150 to 600 cms (South India).
Eucalyptus globulus	West Australia and Tasmania	Eucalyptus	.8 to 1% Bluish green	.9	Cool moist deep fertile soil (non-saline).

1	2	3	4	5	6
Foeniculum vulgare	South Europe	Fennel	4 to 6% Greenish colour	.96	Cold weather crop having mild climate, slightly humus loam.
Glycine soja	Europe	Soyabean	.2 to .5% in some upto 2% pale colour to greenish tinge.	.81	Rich, sandy, well drained alluvial soil and can grow in acidic, neutral and alkaline soils as well.
Myristica fragrans	Moluccas and India	Nutmeg	8 to 10% Pale yellow	.86	Hot, moist climatic conditions with 150-300 cms rainfall, alluvial deep fertile loam sheltered from high winds.
Nigella sativa	South Europe	Kalonji	.46% Yellowish blue flourescent	.87	Mostly in North India, rich humus soil and as occasional scattered cultivation in south as winter crop.
Ocimum sanctum	India and Philippines	Tulsi	.65 to .8% Light green	.81	Throughout India on damp humus soil.
Piper longum	E. Indies	Choti peepal	1% Pinkish green colour	.86	Central Himalayas, South India on well drained limestone soil as summer and winter crop respectively.
Piper nigrum	W. Indies	Pepper	1 to 2.3% red colour	.87	S.W. India, Kerala, Mysore in well drained rich soil, heavy rainfall.
Syzygium aromaticum	E.W. Indies	Clove	15 to 18% Reddish brown	1.04	Warm, moist climate with heavy rainfall on low altitudes

1	2	3	4	5	6
Thea sinensis	China	Tea	.06% green colour	.86	Slopes, well drained cold climate.
Trachyspermum ammi	India, Persia Afghanistan	Ajwan	3 to 4% Brownish	.9	Cultivated throughout India but cold, humid climate it thrives best.
Trigonella foenum graceum	Zingibar	Fengrueck	.01 to 2% Pale green(after anonymous 1916)	.87	Cool, well drained, loamy soil preferably in Punjab, Kashmir etc.

ROLE OF BANKING IN THE DEVELOPMENT OF MENTHA INDUSTRY

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It is only due to a happy turn in the events, that Mentha Oil which before 1960 was a constant drain on our foreign exchange reserves, has with the onset of 70's, developed potentialities of earning foreign exchange. The Mentha industry, technically speaking, covers three stages of production: first, the production or cultivation of Mentha plant or herbs; secondly, the production or extraction of Mentha oil from Mentha herbs and third is the production or manufacture of Menthol from the Mentha oil. The article covers the role of bank finance at first two stages, mainly due to the reason that process of Menthol production from Mentha oil because of being highly technical and expensive, does not possess mass appeal to attract small entrepreneur to come into this field.

However, before we discuss further it will be imperative if we summarise briefly the historical information regarding Mentha plant or herbs.

There are two varieties of Mentha plant.

1. Mentha piperita and 2. Mentha arvensis

Mentha piperita is at present extensively being grown in Europe (England, France and Italy), America (Indiana, Michigan, Oregon, Washington and California States), U.S.S.R. (Ukraine) and Argentina. Though oil distilled from this plant is of very odour, yet its Menthol contents are only about 50%. The process of extraction of Menthol from this oil is difficult and uneconomical also.

Mentha arvensis is being grown in China, Japan, Formosa and Brazil. The Menthol contents of this oil is about 80% and the process of Menthol isolation is also very easy and economic. The oil, however, has bitter and harsh odour as well as taste.

As said earlier, the Menthol and Mentha oil were entirely imported in India before 1960. This induced a few enterprising individuals to investigate the possibility of growth of the Mentha plant in India. Besides, CIMPO (Central Indian Medicinal Plants Organisation) also took up research about the growth of Mentha plant at various places in India and came out with the result that Mentha arvensis is more suited in the areas which has soil conditions akin to that of Tarai Region of U. P. They have further established that yield of Mentha oil from this herb is about 0.45% (green basis) which is as good as in Japan. As a result, two big concerns M/s Richardsons Hindustan Ltd. and M/s Bhavana Chemicals Ltd. started experimental farming in the Tarai area of U. P. and now this area is well established for growth of Mentha arvensis herbs and area under its cultivation is going up every year, covering large portions of Nainital (panes), Rampur, Bareilly, Moradabad, Badaun, Bijnor districts etc.

The cultivation of Mentha herbs

The cultivation of Mentha is becoming increasingly popular in the farmers because of better economic yield in comparison to cultivation of other crops. In order to discuss the financial implications of its cultivation, it will be better if its following aspects are also discussed in brief.

Soil and Climates requirements

Mentha prefers loamy and well drained soil. It can tolerate slightly acid to alkaline soil, i.e. P.H. 6.0 to P.H. 7.5. Loose soils help in growth of its stolans (roots or suckers) and as such those soils which are good for cultivation of vegetables and of potatoes are also fit for ensuring high contents of mentha oil. The plant also does not survive the damp winter which cause root decay.

Planting

The planting is done with suckers during winters, when Mentha lies in dormant stage. It is completed before February-end. Normally about two quintals of suckers are needed per acre. Mentha can also be planted by young transplant either from nursary or from the established field at any time during April to August. Usually, Mentha germinates within 20 days. As the crop should be free from weeds,inter-culture is needed after 30 days of planting and then again after 30 to 35 days from the first weeding.

Fertilisers

Mentha is soil exhausting crop and responds well to nitrogenous fertilizers. Data calculation on N. P. K. requirement indicate that

it can take 50 kg of Nitrogen, 22 kg of Potash and 22 kg of Phosphoras. Normally, 20 kg of Nitrogen, 22 kg of Phosphoras and 22 kg of Potash is given before sowing. Thereafter, 60 kg of Uriais used as top dressing in 4 doses upto second cutting and 30 to 40 kg urea is required after the second cutting in two doses.

Irrigation

First irrigation is needed just after planting and then at least once in 7 to 10 days depending upon weather and soil conditions. In fact, irrigation requirements become more, in order to prevent the shedding of leaves.

Harvesting

Mentha starts flowering by the end of May when it is planted upto February. In order to get optimum Mentha oil, it should be harvested before flowering stage. Normally, its harvest consists of 3 cuttings; first during May-June, second during August-September and third in October-November. Its three harvests, on an average give yield of 25 kg, 20 kg and 10 kg of Mentha oil per acre.

Insects and diseases

Hairy caterpillers and cut worms are the common pests and result in considerable damages. The attack of first on Mentha is observed during May to August and it can be controlled with Eldrin B.H.C. Dust or Thiodin. The attack of second is during February-March when Mentha just sprouts. It is noctural and damages shoots in the night only. Its control was difficult and the only remedy so far was to flood the Mentha fields. Recently, it is reported, however, that application of 5% Aldrin dust using Diptrax bait can control cut worm attacks to a great extent.

It would be seen from above, that Mentha cultivation requires handsome expenditure and the farmer looks forward for finances at appropriate time. On an average, a sum of Rs.3,560 per acre is needed for its cultivation to meet various expenses as would be evident from annexure I. This, however, can yield around 55 kg of Mentha oil which at the market price of Rs.120 per kg will fetch to the farmer Rs.6,600 per acre.

In view of the above, it is easier for the banks to finance the cultivators of Mentha and ensure optimum recovery of their funds. By way of methodology, however, it is suggested that banks should disburse the loan for kind and cash components in three instalments, synchronising with the timing of planting and of each cutting (harvesting). The amount of kind components should be paid to the

suppliers of various inputs, while cash components can be paid direct to the farmer to meet labour and incidental expenses. Further, to ensure farmer's involvement, bank can ask him to meet a portion of cash component as a share of his equity. For the sake of illustration, bank can finance Rs. 2,500 per acre out of which around Rs. 820 as cash components to enable the farmer meet various expenses of planting and first cutting. The remaining expenses for Rs. 180 till this stage should be met by the farmer as his equity. After this stage, however, no further payment in cash is required as he can meet these expenses out of the sale proceeds of first and second harvests. It should be noted that after meeting all expenses, bank's finance can be repaid easily with interest, and farmer is left with a sizeable amount of Rs. 2,140 per acre. (Please see annexure I). This amount can go upto Rs. 3,500 with the rise in the market price of Mentha oil.

So far as the security of bank's loan are concerned, the bank can get the crop hypothecated along with the collateral by way of suitable guarantees or mortgage of the land on the same lines as are adopted for financing other type of crops.

Production of Mentha oil

Mentha oil is produced by extracting it from Mentha herb (plants) usually by following three processes:

(a) Water distillation: The Mentha herb is boiled with the water and fumes generated from this are got condensed for collecting the oil.

(b) Water and Steam distillation: The herb is not boiled with water, but it is kept above the surface of water which is boiled. The steam passes through the herbs and is condensed to collect the oil.

(c) Steam distillation: Steam is produced in separate boilers and is carried to separate stills containing the herbs. The fumes so generated are condensed to get oil.

The first process, though fit for cottage industry, due to low cash components is not advisable as the percentage of recovery of oil is extremely low. The entrepreneur cannot, therefore, generate sufficient funds to run the unit profitably. The third process, on the other hand, ensures maximum recovery of oil but it requires heavy investment and may therefore inhibit the new entrepreneur to enter into this activity despite the availability of bank's finance.

Therefore, it will be in order for purposes of this article, if the scope of bank's finance is discussed for establishing a distillary

with second process, which can be installed as a small scale industry. In annexure II, an attempt is made to illustrate the fixed and working capital requirements of a distillery with a capacity of producing 15 kg of Menth oil per day. The nature and scope of bank's fund has also been encorporated therein. Thus, the total fixed cost (in land and building, fixture) amounts to Rs.60,000 out of which Rs.50,000 are for purchasing the machinery, e.g. distillation unit, condensors and separators. A medium term loan for this purpose can easily be granted by any bank with a covenant for its repayment in 5 years in equal yearly instalments.

The main components of working capital requirements are fuel and green herb (raw material). A limit for about Rs.40,000 can be granted, against the security of stocks to meet one month requirements of fuel and 15 to 20 days requirement of raw material. In this connection it will be easier for the bank as well as for the borrower to pledge finished goods instead of green herb as a security of the loan because the borrower makes payment for the purchase of the herbs so the farmer on the basis of yield of Mentha oil from his crop.

Thus, it can be seen that the industrialist can earn around Rs.45,000 after making all expenditure including repayment of bank's loan, per season (May-June to October-November of about 180 days) if he gets about Rs.170 per kg. out of the sale of Mentha oil, which is quite reasonable.

It may be significant to mention here that there is a good market of Mentha oil which is used for producing Menthol. Menthol is widely employed in pharmaceutical products where it serves as a local anesthetic. It is also used into the tooth pastes, mouth wash and other oral preparations. Mentha is also used for flavouring of candles and chewing gums and for cooling certain brands of cigarettes. M/s Richardsons and Hindustan Ltd., Bhavana Chemicals Ltd., and Crystal India, are a few of the leading concerns who can readily purchase Mentha oil.

In the end it will not be out of place to add that Mentha industry is a lucrative area for business both for the entrepreneurs and for the banks and particularly, it will be better if banks apart from providing finance, extend also necessary guidance to the young farmers and entrepreneurs.

Annexure I

Expenses for Mentha cultivation (per acre)

		Kind components	Cash components
	1st Cutting		
1.	Land preparation	--	180.00
2.	Suckers 250 kg at the rate of Rs 3/- per kg	750.00	--
3.	Planting (Labour)	--	70.00
4.	Fertilizers	350.00	--
5.	Fertilizers (top dressing) 60 kg urea	120.00	--
6.	Irrigation (8) at the rate of Rs 30/-	--	240.00
7.	Weeding	--	400.00
8.	Labour for top dressing (3 dozes)	--	60.00
9.	Plant protection	50.00	--
10.	Harvesting and loading	--	100.00
		Rs.1270.00	Rs.1100.00
	Total:	Rs 2370.00	
	2nd Cutting		
1.	Fertilizers (top dressing)	--	20.00
2.	Fertilizers	170.00	--
3.	Insecticides	60.00	--
4.	Weeding	--	350.00
5.	Irrigation	--	30.00
6.	Harvesting and loading	--	100.00
		Rs.230.00	Rs.500.00
	Total:	Rs 730.00	
	3rd Cutting		
1.	Fertilizers (top dressing)	--	20.00
2.	Fertilizers	120.00	--
3.	Insecticides	60.00	--
4.	Weeding	--	150.00
5.	Irrigation	--	30.00
6.	Harvesting and loading	--	80.00
		Rs.180.00	Rs. 280.00
	Total:	Rs. 460.00	
	Grand Total :	Rs. 3560.00	

Yield in 1st cutting about 25 kg of Mentha oil at the rate of Rs. 120/- per kg	Rs. 3,000.00
Yield in 2nd cutting 20 kg at the rate of Rs 120/- per kg	Rs. 2,400.00
Yield in 3rd cutting 10 kg at the rate of Rs 120/- per kg	Rs. 1,200.00
	Rs. 6,600.00

Bank's Finance

		Kind	Cash
Plant and	1st cutting	Rs. 1270.00	Rs. 820.00
	2nd cutting	Rs. 230.00	-
	3rd cutting	Rs. 180.00	-
		Rs. 1680.00	Rs. 820.00

Total Rs. 2500.00

Net Income to the Farmer

Total earning		Rs. 6,600.00
Less bank's finance		
Principal	Rs. 2500 +	
Interest at the rate of 12% p.a.	Rs. 300	
	Rs. 2800	- Rs. 2,800.00
		Rs. 3,800.00
Less his own expenditure		- Rs. 1,060.00
NET EARNING		Rs. 2,140.00

Note: The above statistics are compiled on average basis after collecting data from 19 farmers of Rampur District, U. P.

Cost of Installation and Requirements of Bank's finance for installing a small distillery with the capacity of producing 15 kilogrammes of Mentha oil per day

1. Land (1/2 acre) and sheds	Rs.10,000	
2. Machinery:		
i) Distillation unit		
ii) Condensers		
iii) Separators	Rs.50,000	Rs.60,000

Working capital requirements

1. Labour and fuel - Rs.300 per day
2. Overhead and miscellaneous expenses for 50 per day.
3. Raw material Rs.1800 per day to purchase enough herb for producing 15 kg of oil

Bank can finance Medium Term Loan for Rs.50,000 for purchase of machinery, which should be repayed in 5 yearly equal instalments.

Further a cash credit limit for Rs.40,000 can be granted to meet working capital requirement against the hypothecation of stocks of finished good for 30 days and of unfinished good for 15 to 20 days.

Sale proceeds of Mentha oil of 180 days production at the rate of 15 kg per day for sale for Rs.170 per kg.		Rs.4,59,000.00
Less oil price at Rs.120 per kg for 2,700 kg of oil		Rs.3,24,000.00
		Rs.1,35,000.00
Less Rs.300 per day fuel cost for 180 days		Rs. 54,000.00
		Rs. 81,000.00
Less 50 per day overhead and miscellaneous expenditure for 180 days		Rs. 9,000.00
		Rs. 72,000.00
Item No, (a)		
Less depreciation of machinery at 10% p.a.		Rs. 5,000.00
Less interest at 12% p.a. on working capital loan	Rs. 4,800	
Less interest banks M.T. loan at 12% for 50,000	Rs. 6,000	Rs. 10,800.00

Less instalment of bank's M. T. loan for Rs. 50,000 payable in 5 equal yearly instalments	Rs. 10,000.00
Less interest on his own capital for Rs. 10,000 for land purchase at 12% p. a.	Rs. 1,200.00
Total of item No. (b)	Rs. 27,000.00
Net result (item a-b)	Rs. 45,000.00

EXPORT AND ITS PROBLEMS OF ESSENTIAL OILS FROM INDIA

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Our first consideration should be to find how far it is a problem and whether or not it is devoid of any solution. No problem is impossible to solve, if the price is paid for it. That means it is purely a question of price to solve these problems.

So let us reflect over it who actually exports from one country to another. Is it the manufacturer, trader, exporter or the Government or the export promotion council? In my humble opinion none of these is a basic factor in exports. All these invariably act like a bridge between an importing country and exporting one. The real personality who delivers the goods are the scientists or technologists. A manufacturer has to follow the tested formulae ethically and devotedly. If the formulae are wrong, then the products so produced will never be acceptable to the importers abroad. Only flawless production would be welcome at the destinations. This means constant vigilance to be exercised by the Masters of Science and Technology.

The next question comes to our view is:

a) Are we lacking natural resources of aromatic plants in our country?

b) Have not we got all the climates in our country; from torrid to the frigid zone.

We notice we have abundant supply of aromatic flowers, aromatic seeds, citrus fruits, aromatic herbs, weed etc. Besides cultivation of these we are blessed with plenty of natural growth, so is true of climates.

Then where is the sang? We have to find an answer to it.

The best way would be to look at those countries which are "successfully exporting countries", in spite of having many difficulties, like unsuitable climate; or partially devoid of natural resources. The more I learn about these countries the more I am convinced, that these countries are not so rich, in natural resources. Let us ponder over it, pursue the proposition with searching eyes and we will find that they have only:

a) Laboratories; and
b) Libraries

Libraries

Before independence many of the libraries restricted consultation of books in our country but now it is not the case and all are open to the public.

Laboratories

Some of these laboratories have done and are doing very useful work, thanks to the sagacity of my late Prof. Sir S.S. Bhatnagar of the Punjab University.

That was the biggest step in our country to create these regional research laboratories through foresight of our beloved late Prime Minister Bharat Ratna Jawaharlal Nehru and Dr. S.S. Bhatnagar.

So we find, we have got the budding resources in laboratories too. But why we are facing this difficulty in the export of essential oils. Simultaneously we find that the large industries are successfully exporting a number of their products both, finished and a few, at raw materials' stage. When we observe carefully, we find each one has got his own laboratory and a small library.

For small scale industries it is beyond their means to have any of these. What they need is:

"Very close coordination with existing laboratories and libraries".

It was a surprise to find that as late as 1960, many of the scientists' papers could only be published in a London Journal "Essential Oil and Record" and we had no resources to publicise. If we want to have more and more coordination between National Laboratories and industry for export, specially from the small scale industry we have to follow the footsteps of Japan. There should be intimate alliance between Regional Research Laboratories and the small scale industry.

The first step should be to publish small booklets in graded form such as:

1) Nursery lessons on the production of Fennel Oil.
2) Primary lessons on the production of Fennel Oil.
3) Senior grade lessons on the production of Fennel Oil.
4) In the last higher studies on the production of Fennel Oil.

Ultimately all these will be combined into one bound volume, a "Masterpiece on the extraction of Essential Oil of Fennel".

Similarly, we can have various publications right from Nursery to Higher studies for the extraction of Rose Oil, Costus Root Oil, etc. This will spread a scientific knowledge with all the details right from ab initio to a higher level for a perpetual student in this field. This amply suits particularly to those who have retired as devoted scientists specially from the field of essential oils.

If possible correspondence courses can be introduced by those who have retired and if they can take further interest then small scale production of only one essential oil or a perfumery grade alcohol can be undertaken. It may be mentioned herein that Govt. of India is going to publish in Indian languages "First Aid to Law" so that the ordinary citizen can understand both obligations as well as can enjoy the fruits of independence. No doubt if we can have "First Aid to the Injured" why not to have on similar basis such introductory volumes as mentioned above for the spread of this useful knowledge.

We some time take it for granted that in our present jobs we cannot do anything to further the prospects of our career. Here I have brought two or three books from the Library and mere scanning on the pages will convince that something can always be done to promote guidance and scientific knowledge for the public at large. May be in due course some royalty could be expected from the sale of these books which suits a retired scientist.

I am firmly convinced that if we have a slogan "Jai Jawan Jai Kissan" because Defence forces lay their lives for the national cause and similarly a cultivator grows food crops for the sustenance of the public at large then I would like to add a phrase as under and I am happy to find that this thing has started to receive recognition both in public as well as in Government circles:

JAI JAWAN JAI SCIENCE DAY
JAI EXPORTER JAI KISSAN

JAI HIND

TAXATION PROBLEMS

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1. Sales Tax and Purchase Tax on oil Mentha (Arvensis) and Sales Tax on Menthol resulting in double taxation - whereas oil purchased from the cultivators should be considered agricultural produce and be exempted from Sales Tax.

2. Central Excise Duty at 10% - This also increases the price of Menthol to a great extent.

3. a) Since Menthol is based solely on agricultural produce, therefore the rates of raw material, i.e. oil Mentha (Arvensis) fluctuate, depending on the availability of the raw material.

   b) Correspondingly, the rates of Menthol also fluctuate from time to time and in such cases if the price has shot-up the Excise Duty of 10% over our approved rates on which the goods were already cleared is to be paid. Contrary to it, if the price has gone down from the approved rate, the authorities do not allow any refund on the cleared material in our stocks. This at time results in heavy loss which the Income Tax Department does not allow and the manufacturer is harassed.

   c) The above points then tempt the small manufacturers to sell their product without a bill thereby escaping the Sales Tax burden and Excise Duty. This results in unhealthy price trends in the market and the established and reputed concerns often find themselves unable to stand.

Apart from the taxation points there are various other difficulties which the industry is faced with and these are:

   i) Import of Menthol and Oil Peppermint against import licenses issued by the Govt. in some form or the other to the influential users.

OR

The flow of the imported Menthol and oil Peppermint in the market by way of release of such goods through open auction by the authorities after confiscation.

ii) No facilities for the analysis and testing of the oil and Menthol by a recognised laboratory are available for small scale manufacturers within the State.

iii) Absence of research and dementholised oil for finding other uses for it and standardising it to the specifications of the pharmaceutical and cosmetic industries.

Suggestions

1. Exemption from Sales Tax/Purchase Tax on the oil.

2. Relief from Central Excise Duty, complete or partial.

3. Provision for the refund of Central Excise Duty already paid, in the event of the rates of Menthol having gone down in the market.

4. No import licenses be granted to the actual users for Menthol or Oil Peppermint/Piperetta or Oil Peppermint B. P. Rather they should be compelled to use the indigenous product.

5. Establishment of a recognised testing laboratory in the State.

6. Research and development to find other uses of Dementholised Oil and efforts to develop our Dementholised Oil to the specifications and Standards of the Pharmaceutical and Cosmetic Industries.