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IN THE PAGES THAT FOLLOW.....



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EDITORIAL 01

AYURVEDA & THE HERBAL PRODUCTS INDUSTRY

Therapy for : Endangered Medicinal Plants 02
- *Janaka A.de Silva*

FEATURES

Tea as a Rasayana- A Pharmacological Review 05
- *B. N. Dhawan, M.D.*

Drumstick tree - A multipurpose miracle tree 10
- *Geetha S Pillai & Indira Balachandran*

Rain Forests - Arsenal of therapeutic agents 11
- *by VIKRAMA*

CELEBRATED RESEARCHERS - 5

NITHYA ANAND - Indian Icon of Drug Development 14
- *R.O.B. Wijesekera*

KNOWLEDGE RENDEZVOUS -

CULLED FROM LITERATURE

BERBERINE - The bright & yellow alkaloid 15
- *R.O.B. Wijesekera*

THE ESSENTIAL OIL INDUSTRY

Essential oils & the related industries 17
- *R.O.B. Wijesekera.*

Technology Variations in the production of essential oils 24
- *R.O.B. Wijesekera*

Essential oils and daily lifestyles 34
- *Ayesha Tanya*

**PHYTOCHEMICALS /
AROMATHERPY/THERAPEUTICS**

Medicinal & Aromatic plants gathered from
wild resources. - Some salient issues 36
- *Vikrama*

FLAVOURS & HEALTH SUPPLIMENTS

STEVIA- "Sweet Herb of Paraguay" 39
- *R.O.B. Wijesekera*

Imitators of Sugar's natural sweetness 42
- *Ayesha Tanya*

THE DIGEST MAIL BAG 43

NOTE TO POTENTIAL CONTRIBUTORS 43

GUIDELINES TOWARDS A NEW GENERATION OF PHYTOPHARMACEUTICALS & QUALITY GUARANTEED HERBAL PRODUCTS

Phytopharmaceuticals, - that means chemical entities derived from plants and in this context inclusive of whole plant extracts or partial extracts, - have been shown to be a major factor in the continuing search for new therapeutic agents, and in policies shaping modern disease control mechanisms. *Phytomedicine*, (-) a specialized international scientific journal committed to the sciences of Phytotherapy and Phytopharmacology, (-) has recommended a new course for research in the field of medicinal and aromatic plants (MAP) and the herbal products industry. The journal in its editorial (Vol 16, 2009, No1) draws attention to requirements concerning analytical standardization of herbal extracts used for pharmacological and clinical investigation and requires that its authors discuss the relevance of pharmacological findings with respect to the known or putative biological activity of constituents of the tested extracts. It adds: "Reviewers will pay special attention to results that appear promising for future development, extracts toward clinical trials, or the use as drugs." This is a welcome departure from the past, as

the western oriented mind-set was sometimes hostile to the concept of extracts as therapeutic agents. Pure chemical entities were deemed necessary as they submitted to easy dosage and quality control. Admittedly modern analytical tools have made it possible to quality assess therapeutic agents which are complex, and contain several possible active chemical entities in a single preparation. Ayurvedic preparations are such complex extracts, and it is a challenge to analytical chemists to derive methods for the quality control of such preparations to ensure safety, reproducibility, dosage management, and adherence to quality standards which may so be derived.

There is a scientific challenge here to place on board Ayurvedic preparations, in a manner that quality assessment and control are ensured as the terms on which the consumer gets the safest and best deal. Adherence to established standards and specifications would place the Ayurvedic preparations on par with any others as far as the consumer is concerned.

Therapy for : Endangered Medicinal Plants

Janaka A.de Silva, Ph.D.,
IUCN Program Coordinator,
Bangkok, Thailand.
(Based on an official IUCN release.)

An initiative, designated, "Saving Plants that Save Lives & Livelihoods", is jointly promoted by three international organizations namely: the International Union for the Conservation of Nature (IUCN), the World Wild Life Fund (WWF), and TRAFFIC which is the Wild Life Trade Monitoring Network. This joint promotion was adopted at the Ninth Conference of Parties of the Convention of Biological Diversity. (CBD).

A joint press release of 19th May 2008, states that the : Saving Plants that save Lives and Livelihoods Initiative, is demonstrating how implementation of international standards can ensure the sustainability of medicinal plant supplies.



Gotukola



Iriweriya.

Species of Medicinal Plants growing in spontaneous fashion.

Each year an estimated half a million tonnes of dried medicinal and aromatic plant material is traded internationally. It cannot be estimated how much more is traded in regional and localized markets worldwide. However it is also estimated that more than 50% of the plant material internationally traded is harvested from the wild, some even from protected sites, illicitly harvested. With the new trends in natural medicines there is a fast growing demand for more and more medicinal plants. Given the increasing land utilization, and habitat degradation in many regions, almost a quarter of the species used medicinally are under threat.

The head of TRAFFIC's Medicinal Plant Programme, Dr Susanne Honnef states thus:

"About 15,000, of the 50,000 to 70,000 plant species used for medicine, cosmetics or dietary supplements, are already threatened."

In many of our developing countries, plants collected from the wild provide the only effective medicine for most of the rural populations. This is especially so in countries of the Asian and the East Asian region where indigenous systems of medicine such as Ayurveda and the Chinese systems, hold sway. People have a deep rooted belief in these systems. Furthermore western medicine is sometimes unavailable to rural folk or, unaffordable. However some of the plants frequently needed are in short supply. They include species such as *Coscinium fenestratum* and *Tinospora cordifolia*, used in common Ayurvedic rasayanas, in the Deshiya medicine of Sri Lanka.

In the richer countries many people have re-discovered the benefits of natural medicine.

The head of IUCN's Species Programme says:

"All over the world, particularly in the developing countries, people depend on medicinal plants, often for primary healthcare. It is critically important that we develop methods to harvest these resources on a sustainable basis."

Dr Uwe Schippmann, Head of the Plant Conservation Section of the German Federal Agency for Nature Conservation (BIN) states: "In 2004 we jointly initiated the development of the: International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants,

(ISSC-MAP). Published in 2007, this standard now provides companies, governments, resource managers, and other stakeholders in the MAP sector a specific guidance tool to develop sustainable use management systems for MAP collected from the wild."

The aim of ISSC-MAP is to halt over-exploitation of precious natural resources, illegal harvesting, and illicit trade in plants harvested from the spontaneous wild flora, by establishing sound quota systems enabling sustainable harvesting methodologies. Central to ISSC-MAP are the following issues which are often breached:

- * The rights of local communities and the indigenous population.
- * The establishment of benefit-sharing contracts between parties in respect of genetic resources and management responsibilities.
- * Prior informed consent of parties (PIC)
- * Mutually agreed terms (MAT)

This is particularly important in the context of Sri Lanka as even scientists have been found to be lacking in the knowledge and importance in respect of some of these crucial aspects.

Now TRAFFIC, IUCN, and WWF together with others, with financial support from the German Federal Ministry for Economic Cooperation and Development (BMZ), have commenced implementing ISSC-MAP in projects worldwide through the joint Saving Plants that Save Lives and Livelihoods initiative. Currently projects are underway in the following countries:

Brazil, Cambodia, India, Lesotho, Nepal, Bosnia-Herzegovina, and, with alternative funding, in China and the Ukraine.

The Head of the Division, Environment & Sustainable Use of Natural Resources of BMZ is pleased with the progress. Mr Fass-Metz states: "It makes us happy to witness the ISSC-MAP being adapted to local contexts, and used on the ground. Several governments, communities, forestry departments and companies have shown a keen interest to support the ISSC-MAP and promote its uptake in their countries. This will help the development of capacity building, technology transfer, and financial support programmes to assist developing countries with the implementation of the Convention of Biological Diversity (CBD).

The current CBD meeting is expected to deliberate on the Global Strategy for Plant Conservation, following recommendations made at the Convention's Subsidiary Body,



Lowland Rain Forest in Sri Lanka Photo by Weeratunga IUCN.

on Scientific, Technical and Technological Advice, at its meeting in Paris in 2007., Sue Liebermann, the Director of the Species Programme of WWF International remarks: "We all profit from the unique therapeutic effects of the medicine from Nature's pharmacy. But it is high time for an effective therapy for natural plant populations under pressure."

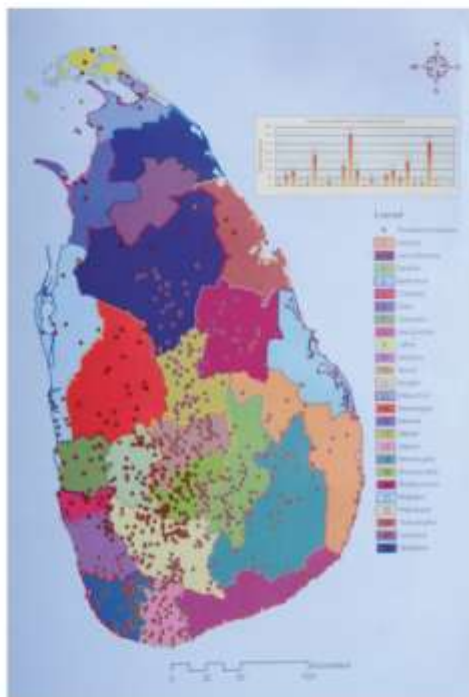
Suzanne Honnef of TRAFFIC adds: "We welcome governments, committed companies and NGO's, to join the initiative, and work to ensure products from wild plants are harvested in compliance with the ISSC-MAP.

There is a message loud and clear here for Sri Lanka. Being an island it has a large number of endemic species and many of them find use in the local Deshiya medical system. They, or many of them have been already designated as "endangered", in the IUCN's 2007 Red List of Threatened Fauna and Flora of Sri Lanka. It is imperative that action be initiated to ensure they do not become extinct, and that they are either cultivated for utilization, and harvested, in keeping with accepted principles of conservation.

The CBD the world's most encompassing conservation convention held the Ninth Conference of the Parties in Bonn on May 19-20, 2008.

Sources of Information.

Richard Thomas, Communications Coordinator,
TRAFFIC <Richard.Thomas@traffic.org>
TRAFFIC Press Release 19 May 2008
IUCN: The 2007 Red List Of Threatened Fauna
and Flora of Sri Lanka.



Distribution of endangered species in Sri Lanka. (IUCN)

TRUTH THE WINNER

"In Science Truth always wins"

Max Perutz. 1914-2002

Nobel Laureate in Chemistry 1962.

OF SIMPLICITY & BEAUTY.

"Molecules, can be beautifully simple and simply beautiful.....
But chemists and artists know that there is infinitely more to beauty than simplicity. Beauty resides, not just in simple things but in the tense edge where simplicity and complexity, where symmetry and asymmetry, where chaos and order contend with each other."

Roald Hoffman 1981
Nobel Laureate in Chemistry,
Quoted by Fiona Case,
in Chem.World : 2007, Dec. p 50.

HISTORY OF SCIENCE

"I think the history of Science has a very invigorating influence on students. If you want to have success in science my advice is simple: aim right but hard. In order to aim right you have to develop an intellectual taste. To do this history of science is crucial, because it shows you what ideas turned out to be important in the long run. Another thing which is also fun is to see that these scientists were also human, as human as you and me."

Pekka Pyykka.
Professor of Chemistry,
University of Helsinki
Finland.

N.B.

Prof. Pyykko in Turku, the site of the first University in Finland founded in 1640. Chemistry was studied there since 1761. He lived at the exact address where Johan Gadolin, the famous Finish chemist lived and since 1984 he occupies a recent version of the original Chair of chemistry of Professor Gadolin in Helsinki.

TEA AS A RASAYANA - A Pharmacological Review

B.N.Dhawan, M.D.

Former Director, Central Drug Research Institute, Lucknow, India, & Emeritus Scientist CSIR, Fellow of the Indian Academy of Sciences and Consultant Pharmacologist to WHO, and UNIDO.

[Adapted from a pharmacological review by: B.N.Dhawan: (2004) published in: International, J.Tea Sci., 3:209-218, - sourced from ninety references. The Editors of Link Natural Products Digest express their appreciation to the author Dr Bhola N. Dhawan, for kind permission to re-publish this review as an adaptation of his originally published version.]



Tea Pluckers in a Tea estate in Sri Lanka.



The "cuppa" that cheers and brings good health

Introduction.

The last few decades have seen the increasing realization that Tea has apart from its merits as a beverage, many properties that warrant it to be regarded as a health food. What is the difference between a health food and a drug? A health food has something positive to offer. It can act as a preventive for certain ailments. On the other hand a drug is administered generally after a disease process has set in. The pharmaceutical industry, which manufactures the drugs, like all other industries, is basically a profit driven one. Its profits are dependent on the disease burden and hence it could regard the promotion of disease-preventing agents as counterproductive. Drugs are generally safeguarded with patents and such is not possible with a health-giving food. However Tea as a health giving food or agent is comparable with the Ayurvedic Rasayanas.

The Nature of Rasayanas

In order to understand the concept of rasayanas it would be necessary to briefly recapitulate the basic tenets and objectives of Ayurveda. The Yadurveda, has stated that the aim of Ayurveda is not just to ensure a life span of a hundred years, but to enable living the hundred years fully and actively. Thus there is a built in concept of the quality of life.

Rasayana therapy forms one of the eight main branches of Ayurvedic therapy. Charaka separates Rasayanas from medicines, termed Kaya chikitsa. Agnipurana also classifies rasayanas as Sarvarogahari aushadi, thus putting them in a different class to medicaments. Rasayana drugs have been defined in Ayurvedic texts in several ways. All definitions nevertheless convey the common concept of attainment of positive health or well being, increased resistance to disease, and assured longevity. They are often confused with the modern "adaptogens". Rasayanas however have a much broader spectrum of activity and adaptation to environmental stress is only one of them. Susrutha says they re-establish youth, strengthen life and brain power and provide capability to counteract diseases.

Sarangdhara offers a more restrictive definition describing the rasayanas as capable of destroying the diseases of old age. Agnipurana improves it by stating that they cure all illnesses and bestows immortality. Charaka however provides the most comprehensive definition. The Charaka samhitha states that: " Rasayana drugs lead to fulfillment of life as a whole. They prolong the life span, ensure a disease-free youthful life, with, vigour and good control of bodily functions, a resounding voice and a glowing complexion." The Charaka treatise has classified 34 plants as generating rasayanas, some of them being dietary (ayasika) rasayanas.

This review attempts to evaluate the available data on Tea and its constituents and to assess it in the role of a dietary or classical rasayana.

Major Activities of Rasayanas, which are amenable to Laboratory Evaluation.

It is evident therefore that Rasayanas are expected to exhibit multiple activities. Hence it would be necessary to employ a battery of tests to uncover their activity profile. Three major activities of the rasayanas could be evaluated on the basis of animal models. These are the following:

1. The effect on general bodily and mental functions.
2. Altered resistance to diseases caused by stress, toxins, infections, xenobiotics etc.,
3. Effect on ageing and life span.

Several parameters have been used to evaluate these activities. These can be grouped under the following six heads.

- * Actions on the immune System.
- * Response to stress.
- * Mental activity.
- * Selected physiological functions.
- * Regeneration following injury.
- * Ageing

It is beyond the purview of the present presentation to discuss these and they are elaborated in detail elsewhere. (See Dhawan and Srimal 1998, Nodine and Siegler 1964, Siegler and Moyer 1967, Turner 1971.)

Comparison of Activities of Tea with the Rasayanas.

Rasayanas are expected to re-establish youth, strengthen life and brain functions, and provide capability to counteract diseases. That is according to Susrutha. The Chinese scholar Lu Yu in a treatise written in 780 AD entitled Cha Ching, states: "tea tempers the spirits, harmonizes the mind, dispels lassitude, relieves fatigue, awakens thought, prevents drowsiness, refreshes the body and clears the perspective faculties." Even from these early descriptions the similarities become apparent. A comparison of these in the experimental paradigms mentioned above together with some clinical evidence should enable a better assessment of the similarities.

A. Response to Stress.

Rasayanas modulate response to all types of stress.

This means all types : Physical, Chemical Microbiological, or Endogenous stress like cancer. The effect of Tea and its constituents on responses to stress has not been too thoroughly investigated. However data extrapolated from several reports and clinical studies are summarized below under four heads.

Physical Stress

In a study on human volunteers conducted in 2000, it has been recorded that local application of the polyphenols of green tea can bring about a reduction of sunburn and DNA damage following exposure of the skin to UV-radiation.

Chemical Stress.

The Effects of the constituents of Tea on Chemotoxins have been studied. In the category of non-specific chemotoxins, prevention of mutagenic effects of carcinogens and pro-carcinogens have been recorded by Japanese workers. The effect against specific toxins has been studied in several tissues. Liver is protected against damage by galactosamine, aflatoxins, lipopolysaccharides, etc., as recorded by Chinese workers in 2001. The DNA adduct formation by nitro-propane is also inhibited. Renal failure induced by adenine or cBSA, is prevented by the

polyphenols of green tea, and a beneficial effect has been noted in patients, following renal dialysis. Hot water extracts of green tea prevent has been shown to prevent bone marrow damage by Aflatoxin B.

Amelioration of b-amyloid neurotoxicity has been seen in cultured hippocampal cells. Selective inhibition of prolyl endopeptidase by constituents of tea such as (-)-epigallocatechin-gallate, (-)-epicatechingallate, and (-)-galocatechin, has also been reported. These properties may find application in the management of conditions such as Alzheimer's disease. Likewise the protective effect of Tea catechins, against 6-hydroxydopamine induced apoptosis in PC-12 cells suggests a possible utility in Parkinson's disease.

Microbiological Stress.

Tea extracts have been reported to inhibit the growth of many viruses including HIV, micoplasma, fungi, protozoa, and bacteria both gram positive as well as gram negative. They can also suppress the emergence of resistance to anti-bacterial agents, and potentiate the activity of beta-lactam antibiotics. Recent Japanese work finds that Thesinensin A, suppresses antibiotic resistance of methicillin-resistant *Staphylococcus aureus*,

A synergistic effect with some anti-bacterial agents has also been reported. This has recently been recorded in the case of leoflaxacin, against e.coli. Further the protection of tea against the causative organisms of dental caries is well documented.

Response to endogenous Stress.

A large amount of epidemiological, clinical, and experimental data is now available on the beneficial effects of tea on patients suffering from several types of cancer. For example, there is significantly lower incidences of lung, digestive tract and skin cancer reported in communities who have a high intake of tea, in particular green tea. Green tea has been reported to possess anti-cancer properties in experimental models as well. Tea flavanoids can inhibit a pulmonary neoplasm induced by urethane and NNK - a nicotine-derived carcinogen. Tea can also inhibit the induction of apoptosis and anti-clastogenic effect in experimental models of leukemia, and gastric carcinoma. In Vito studies have

demonstrated the ability of tea polyphenols to reverse multi-drug resistance to cancer cell lines and display synergistic activity with cancer preventing agents such as: genistein, sulindoc and curcumin as well as anti-tumor agents like doxorubicin.

B. Effect on the Immune System.

Rasayanas, have immune-stimulant properties. Some of them in addition display anti-allergic activity.

Tea extracts and the constituents also share some of the general attributes of rasayanas.

Some pertinent experimental and clinical data is summarized in the following:

Immuno-modulatory action of Black Tea.

The novel melanin-like pigment derived from black tea has been shown to have immuno-modulatory activity.

Black tea can also reverse EAC- induced immuno-suppression.

Anti-allergic activity.

Tea catechins have been shown to inhibit PCA in rat and mouse models, and autoimmune disease in MRL-fas/fas mouse. They suppress expression of high affinity IgE receptor FC Epsilon R. Green tea polyphenols have displayed beneficial effects in guinea pig allergic rhinitis model. Recent work has also shown facilitation of antigen-specific anti-body production through selective augmentation of IL-2 generation in vitro as well as in vivo, by extracts of tea.

Clinical Data.

Oolong tea has been shown to have a beneficial effect in patients of atopic dermatitis and allergic rhinitis. There is an improvement in the CD4/CD8 ratio with the green tea.

C. Effect on Physiological Functions.

Rasayanas improve physical performance and stamina, optimize food utilization, are potent anti oxidants, and can restore disturbed carbohydrate and lipid metabolism.

Tea extracts as well as their constituents share many of these characteristics. A brief summary of the considerable available data is included here within six headings:

*** Work Performance.**

Tea extracts facilitate skeleton-motor function by action on L calcium channels, and are known to alleviate post-game fatigue in athletes. They have been given to horses in Tibet to increase their capacity for work.

*** Food intake and Body weight.**

An ethanol extract of green tea was found to inhibit gastric and pancreatic lipases, and to stimulate thermogenesis. It was found to exert a weight-reducing effect in clinical studies on moderately obese patients. Intra-peritoneal administration of (-) epigallocatechin-3-gallate, produced a reversible 20-30% reduction in body weight in 2-7 days due to a reduction in food intake. An anti-obesity effect has been reported also on female mice. More data is needed to evaluate this effect.

*** Carbohydrate metabolism.**

A hypoglycaemic effect has been reported in a variety of experimental models including: normal, streptozotocin, fructose or alloxan diabetic rabbits and KKA mice. Aldose reductase activity is inhibited in streptozotocin diabetic rabbits, thereby slowing the process of nephropathy and cataract. The secretion of insulin is not effected in diabetic animals. It however caused a more than fifteen fold increase in sensitivity to insulin, in an in vitro epididymal fat cell assay. The main active ingredient was (-) epi-gallocatechingallate. A lowering of blood glucose has also been noted with a polysaccharide from tea, which is coordinated with rare earth metals. Clinically, lowering of blood sugar and HbA_{1c} and slowing the process of nephropathy in patients with diabetes mellitus, has also been reported.

*** Lipid metabolism.**

Recent work has also indicated that extracts of Green Oolong and black tea, modulated lipid metabolism in hyperlipidemic rats fed high sucrose diet. Catechins also prevent

atherosclerosis in hamsters on a high fat diet, in apoprotein E deficient mice by inhibiting activity of p-glycoprotein. Cholesterol biosynthesis is prevented by selective inhibition of squalene peroxides. Clinical data supporting hypolipidemic activity of tea constituents include lower levels of serum cholesterol, LDL, and VLDL, along with raised level of HDL, reduction of atherogenic index, and lowered level of the adhesion molecule P-selectin. Green tea extract enhances neutral endopeptidase activity in SK-N-SH cells thereby preventing the formation of amyloid plaques. Oolong tea suppresses oxidation of LDL in a dose dependent manner.

*** Detoxification mechanisms.**

Tea polyphenols induce xenobiotic detoxifying enzymes like cytochrome P450 1A1, 1A2, 2B, and UDP glucuronyl transferase. They can also prevent heavy metal toxicity by chelation.

*** Anti-oxidant activity.**

Tea polyphenols effectively scavenge the reactive oxygen species, (ROS) which are a major contributory factor in cellular injury.

D. Effect on CNS Activity

Rasayanas facilitate learning and consolidation of memory, antagonize CNS effects of stress, are anxiolytic and capable of interacting with some neurotransmitter mechanisms.

Tea constituents have been shown to improve learning and memory in senescence accelerated mice especially in the older animals. They can antagonize beta-hydroxy dopamine induced apoptosis in PC-12 neurons which is an in vitro model of Parkinsonism. The toxicity of nitric oxide on hippocampal neurons is also antagonized. Thearubigin fraction can block the paralytic effect of botulinum and tetanus neurotoxins. Theanine protects against ischaemic delayed neuronal death. The activity of several enzymes linked to monoamine neurotransmitters like tyrosinase COMT and MAO, can also be effected. Epicatechin gallate inhibits neurosphere adhesion, cell migration, and neurite outgrowth in rat neurospheres. It might effect neural stem cell survival or differentiation.

E. Facilitation of Tissue Regeneration

Rasayanas reduce time for regeneration of damaged tissues; they also lead to a better functional recovery, after injury due to ischaemia re-perfusion, toxin, or surgical resection.

The data with the constituents of tea is rather limited, and further in-depth studies are strongly indicated. Green tea has been reported to facilitate recovery from ischaemia reperfusion injury of the forebrain in gerbils, and of brain and gastric mucosa in rats. Similarly repair of DNA damage by mutagenic agents is facilitated.

F. Anti-ageing effect

Rasayanas improve lifespan help retain efficient task performance, and retard development of biochemical markers of ageing.

A large amount of epidemiological data is available from well planned surveys of tea drinkers but very few experimental studies. Lower mortality rates have been reported in Japanese women who practice the traditional tea ceremony. The incidence of debilitating and killer diseases is also less. Protection against hip fracture has been noted in a population based study and a significantly higher bone density in spine and hip region in tea drinkers aged 65-70 has also been recorded. A Dutch cohort study suggests a lower risk of death from coronary artery disease or stroke in tea drinkers. In a Boston study the risk of heart attack was assessed to be lower in persons drinking one or more cups of tea a day. Furthermore in a review of cohort studies lower incidence of cancer of the oesophagus, stomach, colon, and pancreas in drinkers of green tea has been recorded.

Tea versus Other Health Drinks

An interesting study conducted in Turkey compared the anti-oxidant properties of various health drinks with the respective phenolic content, and a good co relation was observed. They also found that the phenolic content per serving was higher in liquid foods than in solid foods. The highest ranking was obtained for black tea from among the commonly consumed liquid foods in that country. Black Tea was followed by Instant coffee, cola drinks, red wine,

carrot juice, apricot nectar, Turkish coffee, grape molasses, and white wine in descending order.

Does the Colour of Tea matter?

The majority of Tea drinkers (78%) take black tea. The tea is taken as such or with milk (50% of tea drinkers). Green tea, the next commonly used tea, is taken by an estimated 20%. All these are rich in the original polyphenols like (-) epigallocatechin, and related catechins. The Red (Oolong) Tea is mainly used in certain parts of China, and accounts for only 2% of the total consumption of tea. Recent work suggests that all varieties of tea contain the same type of polyphenols with variable compositions yet they all have similar physiological effects.

The following is a translation of an old Chinese poem by Jhawar, which relates to the number of cups of tea to be consumed.

*"One cup does all disorders cure
With two your troubles will be fewer
Three to the bones more vigour gives,
With four for ever you will live
As young as on your day of birth!"*

Concluding remarks

This brief review, (the original publication referred to has all the relevant references to the research), indicates that the constituents of tea exhibit to a significant degree, all the beneficial properties attributed to Rasayanas in the Ayurveda. It can be safely predicted that had tea been available in India when the major Ayurvedic treatises were being compiled, it would have found a place as a Rasayana. Its introduction to India in the 18th century, was too late for it to be included in the Ayurvedic texts. **It is suggested that the Tea industry should promote tea as a Rasayana as well, or even as a health food, rather than just as a refreshing drink. It is necessary that adequate funding be made available for experimental, epidemiological, clinical, studies for research in areas where more information is needed.**

Reference:

As cited in Chapter 35: TEA - A HEALTH FOOD OR RASAYANA DRUG. International Journal of Tea Science Volume 3&4, (2004) by the author of the original review, B.N.Dhawan.

Drumstick tree - A multipurpose miracle tree

Geetha S Pillai and Indira Balachandran

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Arya Vaidya Sala, Kottakkal - 676 503,
Malappuram, Kerala, India



The drumstick tree or horseradish tree (*Moringa oleifera* Lam.; Moringaceae) is a small or medium sized rapidly growing perennial soft-wood tree, indigenous to North-West India and found wild in sub-Himalayan tracts of India, Afghanistan, Bangladesh and Pakistan. It is being grown in West, East and South Africa, tropical Asia, Latin America, the Caribbean, Florida and the Pacific Islands. It is an important crop in India, and cultivated all over the plains, in hedges and home yards. The tree can be propagated by seeds or from cuttings. The plants raised through seeds are mostly poor performers and hence propagation of selected trees through cuttings is preferred. All parts of the Moringa tree are edible, as well as medicinal. Plant parts have been used to combat malnutrition, especially among nursing mothers and infants. The tender fruits are main source of vegetable. The fruits are cut into slices and used in culinary preparations and also used pickled. The fruits are long whip-like and a good yielding tree gives more than 1000 fruits. There are not many named varieties in this species in India. 'Jaffna' types produce long fruits (60-90 cm and 90-120 cm).

The flowers and leaves are also used as vegetables. Moringa leaves that are available throughout the year, are rich in protein, Vitamin A, Vitamin C, calcium, iron, potassium etc and can be eaten fresh or cooked and hence are a very rich source of dietary nutrients. The flowers contain traces of alkaloids, quercetin and kaempferol and the ash is rich in potassium and calcium. The seeds are also eaten green, roasted, powdered and steeped for tea or used in curries. Moringa seed oil (Ben oil or Behen oil), is non-drying, non-sticking oil with a mild pleasant odour, that has been used for edible purposes in salads, in the manufacture of perfume and hair care products, in illumination, and also for fine machine lubrication. The roots are considered as a condiment and garnish like the original horseradish. Roots contain an active antibiotic principle, pterygospermin, which inhibits the growth of many gram positive and gram negative bacteria. The root bark contains alkaloids such as moringine and moringinine. The gum obtained from the tree trunk is used in calico printing. This tree has been valued for its use in traditional medicine from time immemorial. All parts of the tree are medicinal and used in the treatment

of ascites, rheumatism, venomous bites and as cardiac and circulatory stimulants. It improves appetite and digestion, promotes semen and is good for heart and eye problems. The roots of the young tree and root bark are arborifacient and anti-inflammatory. Leaves are galactagogue and promote breast milk secretion, useful in catarrhal affections and scurvy and an emetic. Leaf paste is applied externally for wound healing. Flowers are used as tonic and diuretic. The seeds are antipyretic, acrid and bitter. The seed oil is applied in rheumatism and gout. Moringa preparations have been reported to have hypotensive, hypo-cholesterolemic, hypoglycemic, hepato-protective, antispasmodic, anticancer, antiulcer, anti-inflammatory and antibacterial activities.

The nutritional and medicinal properties of Moringa are now well established. Moringa has other uses as well like biomass production, live trees for fencing, biogas from leaves, crushed leaves as domestic cleaning agent, leaves as green manure, leaves and treated seed-cake as animal forage, seed-cake as fertilizer, gum from tree trunks, powdered seeds for water purification etc. Its uses are so unique as its certain names like 'clarifier tree', mother's best friend (in East Africa) etc indicate. Despite its known nutritional and medicinal properties, this tree has perhaps been one of the most under-exploited tropical species.

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Rain Forests – Arsenal of therapeutic agents.

By VIKRAMA



Introduction.

Since the days prior to recorded time, man survived in a symbiotic relationship with his biosphere. From it he gathered his food, the materials, which account for his clothing, and to construct his shelter, his medicines to combat disease, and even the poisons for his arrows and weapons to serve his aggressive intents. The forests were the major resource.

Forests are areas which are categorized as possessing a high density of trees, albeit with the accompanying undergrowth and other plants between. They comprise about a third of the earth's land area. Forests are important because they house organisms of many kinds, act as a mechanism of soil conservation the live version of the so-called Nitrogen cycle. Forests are also the hydrologic flow modulators a natural mechanism it would seem for the utilization of water to sustain growth. This constitutes one of the most important aspects of the earth's biosphere. The forest therefore provides an enabling situation for a very wide range of plants to thrive and hence it is a resource that can serve the needs of mankind if employed in a most sustainable way. Forests are also home to many animal species as well, as biomass per unit area is high in forests when compared to other vegetation communities. Much of this biomass occurs underground alongside the root systems as partially decomposed plant detritus. The major forest types are:

- * Rain Forests (tropical and temperate)
- * Taiga
- * Temperate hardwood forests
- * Tropical dry forests

Tropical Rain Forests

The most abundant forests from the point of view of the occurrence of plant and animal species are indeed the rain forests which account for between an estimated 40-75% of the species on earth. It is also estimated that many millions of plant and animal species are yet to be discovered and therein lays the value of the forests and the importance of conservation. Tropical rain forests have been termed the "world's largest pharmacy". Rainforests are also important because they enhance the world's supply of atmospheric oxygen through natural photosynthesis from carbon di oxide. Tropical rain forests are those that lie between the tropic of cancer and the tropic of Capricorn roughly south and south-east Asia, north eastern Australia, sub-Saharan Africa, South and Central America and some pacific islands. These forests are characterized by high rainfall, and a canopy of tree tops that render undergrowth scanty, which makes it possible to walk through the forest. In some of the rain forests of Indonesia, Costa Rica, and even in the Sinharaja Forest reserve in Sri Lanka, one can notice a deep darkness even in broad day due to the canopy above which cuts out the sunlight.

In a tropical rain forest four main layers are identified, each with its own array of plants and animals, which are adapted for living in that particular area, the emergent, the canopy, the understory, and the forest floor? The emergent layer consists of a number of large trees which are called "emergents". These extend above the general canopy and are able to withstand the strong winds and the heat of the sun. They are the home of eagles', butterflies, and certain types of monkeys.

The canopy layer contains the majority of the trees and is the densest area of the rain forest; indeed it is richest in terms of foliage. Canopies of rain forests are home to an estimated 50% of all plant species and so the staggering richness in terms of the secondary metabolites that constitute therapeutic agents can well be imagined. Over the centuries the Rain Forests of the world have been ruthlessly exploited for many purposes; for agriculture and food supplies, creation of artificial lakes and dams, for the traditional medical requirements, and most of all for timber, which has devastated the forest regions and resulted in many problems not the least of them being global warming.

Sustainable use and the Pharmaceutical Industry

If the rain forests are the treasure trove of mankind then it is imperative that they are sustained and sustainable use of the resource is the guiding principle. Unfortunately it would appear that the global community has left this too late. Further devastation would mean that many plant species would be lost for ever. The endangered list is already too great. The use of forest plants in traditional medicine cannot be the culprit to any measurable extent. Traditional communities are indeed responsible for abuse of resources but the scale is small. Worldwide it has been the case, that, huge companies searching for New Chemical Entities (NCE) for purposes of drug discovery by large multi-national agencies have been responsible for the extensive devastation of medicinal plants growing areas in Africa, and Latin America. The research on Natural products as a source of novel therapeutic agents reached a peak during the period 1970-1980, resulting in a pharmaceutical drive away from synthetics which had begun to dominate the scenario of drug development. Of a total of 877 NCE's introduced between 1980-2002 49% were from natural products or molecules related to those derived from natural products. This phenomenon was preceded by large scale exploitation by industry of forest areas where medicinal plants dominated. For example the NIH in the USA sponsored a large drive to collect and investigate plants in Africa which had anti-cancer potential. One wonders if the aspect of sustainability entered the equation. The overall trend in the interests in Natural products experience some decline from the huge boost it enjoyed during the decades 1980-2000. The slight decline is explained by Koehn and Carter as due to the following factors:

- * The High Through-put Screening (HTS) procedures which came into play which made hordes of synthetic chemicals rapidly assessable against defined molecular targets.
- * The development of combinatorial chemistry which opened the prospect of screen friendly libraries of chemicals of wide diversity.
- * Advances in molecular biology, cellular biology, and genomics which offered added molecular targets with possibilities of shorter drug development time lines.
- * Declining interest in the pharmaceutical industry in infectious disease therapy

where natural products were traditionally strong. (In other words a decline in interest in medicines for the third world where profits may be degree-wise less?)

* Uncertainties in the collection of raw materials accentuated by the Rio Convention on Biodiversity of 1992.

Koehn and Carter summarize their observations thus:

The underlying reasons for these industry trends are as much commercial as they are scientific, particularly in the case of infectious diseases. Today's drug discovery environment calls for:- rapid screening; hit identification; and hit-to-lead development.

In this context natural product development programmes will face difficulties. They depend on acquisition of the natural raw materials, extraction and bio-assay guided fractionation, structural elucidation and scale-up process technology with scientifically optimized process protocols, which will be time disadvantageous and expensive. The industry missed out, on the very reasonable prospect of standardised extracts, which are possible with today's instrumental facilities such as HPLC, and which smaller companies in the third world have now begun to utilize, for health care agents.

Leads for Drug Discovery

Current trends in drug discovery value the high molecular diversity that natural products provide. They also recognize the biochemical specificity of some of these natural molecules and their copies, and they are a favorable lead to the discovery of new drug forms. Furthermore natural products invariably possess a greater number of "chiral" centres, and hence greater stereo-chemical complexity, which accounts for their specificity in action. They are generally more difficult to synthesize as a result. Some of the active ones that are in therapeutic use are still obtained from natural sources such as for example the highly successful anti-cancer agent Vincristine from *Catheranthus roseus*. Thus it now appears that industry recognizes once again that natural products is a fruitful area for drug development. The most fruitful area to search for drug leads is indeed the diverse chemical structures within natural products which provide a molecular scaffold which embodies the possibility of binding with multiple target proteins a feature which gives rise to drug-action specificity. Even if the active principle of a natural plant product is suitable as a drug, improvements of drug

specificity and diminished toxicity can be envisaged by synthetic manipulation of the natural molecule on the basis of such considerations. Such chemical structures are now referred to in the industry as "privileged structures", and natural products are viewed as a population of privileged structures, selected by evolutionary mechanisms, to interact with a wide variety of proteins and similar biological targets, to render specific activity profiles. This is confirmed by the observed fact that natural products have served as effective drugs for a wide range of therapeutic conditions.

Table 1

Some compounds isolated from plants displaying wide ranging chemical structures & different activity profiles

Forskolin	Cardiovascular
Quinine, Artemisine	Antimalarials
Vincamine, Vincristine	Anticancer
Lovastatin	Anti-cholesterol
Micafungin	Antifungal
Chamazulene	Anti-inflammatory
Silybin	Hepato-protection
Discodermolide	Anti-tumour

Concluding observations.

A different view of rain forests is created by the above considerations in which the secondary metabolites of plants serve as a vital human resource for combating disease. If the plants are a new and vast repository of such value the global thrust towards effective conservation and sustainable utilization takes on another and most compelling dimension. Thus the remarkable chemical diversity represented within the vast rain forests of the world may be the future savior of the human race. Its preservation for generations to come, when new methods for sustainable use may emerge, is a crucial responsibility of the present towards the future.

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NITHYA ANAND - Indian Icon of Drug Development

R.O.B. Wijesekera

Nithya Anand is a genial, polite and well mannered personality. Working with him, - which the author had the privilege and pleasant experience of doing-, makes one realise the quality of a scientist of deep knowledge and strict self discipline. He has been known as Nithyanand as well as Nithya Anand, a name one learns he owed to his original research supervisor the renowned Professor K.Venkataraman.

Nithya as he is affectionately known was born on New Years day in Layallpur which now belongs within the borders of Pakistan. He came from a family of scholars both parents being teachers, his father a professor and his mother a principal of a College. So there was no escape from the academic environment for the young Nithya. This would account for the principled nature he brings to all his work.

Coming to post-independence India after his B.Sc from Lahore he researched in Bombay with Venkataraman for his Ph.D. He was later to obtain another Ph.D working with Lord Alexander Todd in Cambridge, England, where he did synthetic work on nucleotides. Then he joined the newly formed Central Drug Research Institute in Lucknow in 1951 and remained there till he retired in 1984, where he was Director for a decade 1974-84. His post-doctoral spells were at the Harvard Medical School in Boston under Professor Bernhard Davis, and here he honed his drug development skills which were to identify him over the years as an Indian icon in the field of Drug research and development.

His monumental contribution to Science in India includes the training of over 80 researchers some of whom themselves have achieved high status in the field. The author first met this modest scientist in 1964 during a visit to Indian laboratories under the aegis of the CSIR and several times later but came to know him best when he was on the Science & Technology Advisory Committee of the WHO, when the author himself was managing a WHO Task force for Research on Plants for fertility regulation.

Since then Nithya served as a Senior Consultant to the UNIDO Programmes on Medicinal and Aromatic Plants which the author managed. In particular he was the Consultant



for major UNIDO projects in Nepal with the Royal Drugs Research Laboratory and the Herb Production and Processing Laboratory in Katmandu. The author interacted with him during this period 1984-90, and came to value his qualities of leadership, his vast knowledge and his analytical approach in decision making. He was indeed an inspiration to those who worked with him. The author could never forget how in his mild manner he would call at the author's room in our hotel in Katmandu when on duty there, for the ritual early morning stroll, and with Nithya it was almost a military march.

During this period he became intensely interested in understanding the Philosophy and techniques of Ayurveda and wrote an erudite review on the subject

It is no surprise that many tributes have been paid to him for his scholarship, his research, and his leadership of a singularly important institution the CDRI of Lucknow. In collaboration with his wife Swarn Nithyanand he has conducted research into developing Ayurvedic drugs in modern scientific form and has many successes in this area.

This author would like to add his humble tribute to one of the great scientific personalities of the sub-continent, and to a disciplined gentleman whom he is proud to have worked with in the service of others.

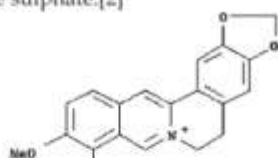
BERBERINE - The bright & yellow alkaloid

By R.O.B. Wijesekera

One learns in early lessons in organic chemistry, that alkaloids are a naturally occurring class of compounds which are characterized by their bitter taste, that they are generally colourless or white, and that they are organic bases. All this is true for most alkaloids, but one striking exception is the bright yellow alkaloid berberine. It is bitter and basic, but in colour it is strikingly different. In the Sri Lankan Deshiya Ayurvedic treatment a decoction containing roots of the plant known as Weniwel, is included to combat any after effects of injury. It is believed to act as a prophylactic against tetanus. The plant is botanically known as *Coscinium fenestratum* L., and its chief chemical constituent is the alkaloid berberine. Berberine was first isolated in *Coscinium* species by Nathanael & Child, of the Coconut Research Institute in what was then the crown colony Ceylon.[1]. Subsequently, in 1954, De Silva and Wijesekera isolated Berberine and a related alkaloid protoberberine, from *Coscinium fenestratum*, and developed a pilot-scale method for the production of crystalline berberine sulphate.[2]

Berberine, is found in many plants such as: *Berberis aristata*, which is extensively used in the Ayurvedic system in *Berberis aquifolium*, *Hydrastis canadensis*, and *Coptis chinensis*. The alkaloid is found in the roots, rhizomes and stem barks of these plants.

In Sri Lanka as well as in Viet Nam, and the north American region, the chief source of this alkaloid is the presently endangered plants *Coscinium fenestratum*, and *Hydrastis canadensis*. The plant *Hydrastis canadensis* known in popular terminology as Goldenseal or Orangeroot, originates in Canada. Whereas *Coscinium fenestratum* belongs to the family Menispermaceae, and is a vine around a host tree, the plant *H. canadensis* is quite different and is classified as belonging to the family Ranunculaceae, or the buttercup family. Goldenseal is used as a popular traditional herbal multipurpose remedy. It is associated with anti-inflammatory, emmenagogic, anti-catharrhal, oxytocic, and laxative properties.[3]



Berberine



Roots of *Coscinium*



Coscinium fenestratum



Hydrastis canadensis



C. fenestratum (fam) Menispermaceae.

Berberine extractions and decoctions have demonstrated significant activity against a variety of organisms including bacteria, viruses, fungi, protozoan, helminths, etc. Currently the predominant clinical uses of berberine include bacterial diarrhea, intestinal parasitic infections, and ocular trachoma infections.[3,5].

In Sri Lanka it is mainly regarded as a prophylactic against a possible tetanus infection, and in controlling painful conditions following injury. It is a constituent of many decoctions.

The pharmacologically identified actions of berberine include metabolic inhibition of certain organisms, inhibition of bacterial enterotoxin formation, inhibition of intestinal fluid accumulation and ion secretion, inhibition

of smooth muscle contraction, reduction of inflammatory conditions, inhibition of platelet aggregation, platelet count elevation in certain types of thrombocytopenia; stimulation of bile and bilirubin secretion; and inhibition of ventricular tachyarrhythmia. [3,4]

Clinical Applications of Berberine.

The recognized clinical applications of berberine can be summarized as follows:[5-7]

- * Bacterial Diarrhea
- * Treatment of intestinal parasites
- * Treatment of ocular trachoma infections
- * Cardiovascular disorders eg. Congestive heart failure (CHF)
- * As an anti-inflammatory agent
- * A cholesterol lowering agent

Other potential uses of berberine may be on account of its tendency to lower blood pressure, and cause peripheral circular dilation. It also leads to inhibition of the functional cascade that ultimately leads to platelet aggregation and clot formation. Berberine also possess anti-angiogenic properties.[8,-10]

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THE ESSENTIAL OIL INDUSTRY

ESSENTIAL OILS AND THE RELATED INDUSTRIES

By R.O.B.Wijesekera.

Let us begin by understanding what are essential oils. The earliest humans noted that certain plants were attractive because either their flowers or other parts just smelled good. They were used to adorn the human body in particular the female of the species. Thus began the use of "cosmetics" and fragrances. The earliest recorded history goes back to Egypt circa 2920 to 2770 BC. Archeological studies on the excavated tombs of this era, showed jars of fragrant materials with entrapped aromatic oils. "Essential oils", constitute the fragrant portion of the natural materials used during these early times. Why "essential"? This does not connote the idea of great need. It is derived from "essence," and hence the confusing, original English term "essential".

Essential Oils, are also termed "volatile oils" which is a more appropriate term as we shall see. The fragrance of plants, are due to the comparative volatility of the essential oils that constitute that fragrance. They have been isolated by man from the plant material, since the early days, by a variety of physical techniques that took into consideration their volatile property.

In German, Essentials Oils are termed: "Aetherisches Öl". "Aetherisch" denotes "ether," which in old terminology refers to the air. This signifies that the oil evaporates into the air.

History



Archeological research has also shown that even as early as 3000 BC, the technique now known as "steam distillation" was employed to make fragrances. This was at the zenith of the ancient Arabian civilization. In India too there are reasons to believe that the methodology for the production of "attars" or concentrated fragrances came, from this early Arabian civilization. In China, the Emperor Huang Ti, published a book in circa. 2000BC, called the Book of Inner Medicine. It describes the causes of disease and their treatment with massage, acupuncture, and aromatic oils, - the early beginnings of what we today call "Aromatherapy".

The Egyptians knew of the disinfectant properties of the Essential Oils and used them for disease control and of course for mummification. It appears that during the first century AD, the Persian civilization extensively produced essential oils. They took the technique to India, and, also to southern Europe, where they founded Universities in Spain and France.

The European Essential Oils and Fragrance industry began in around the 12th century. Perfumers in Europe began to produce essential oils by distillation and by the process known as enfleurage. This was extraction of the essential oils with a fatty substance such as vaseline. The technique, particularly applied to flowers such as jasmine, lavender, and rose, was well established in the South of France and Spain. Museums in Grasse, such as the Fragonard Museum, display models of the distillation stills used at the time, and the fragrance containers designed for the trade

In 1500, Brunschwig, a physician of Strasbourg described the manufacture of Essential Oils.

The pharmacopoeias of the cities of Nuremburg and Augsburg have documented the use of 108 distilled essential oils, in, trade and industry.

When the era of colonial exploration and conquest began, in the sixteenth century, the Europeans latched on to the fragrance and piquancy of oriental spices. And so began the introduction of essential oils to the Food and Beverages Industry in addition to the Fragrance and Perfumery Industry. Spices became the important currency of international power and prestige. Spices and fragrance material were shipped from the Asian region and the East to Europe, in order to augment a now thriving European Essential Oil industry, as well as a fast developing Fragrance and Perfumery industry.

Sources and Natural Occurrence.

Essential oils are responsible for imparting the characteristic odour to aromatic plants. Thus the freshening aroma of a mint or the fleeting fragrance of citronella is due to the slow volatilisation of the essential oil within them. So also the characteristic scent of a rose, a jasmine, the bewitching smell of sandalwood, or the flower of ylang-ylang, these are some of the specific attractions of the plants that man went after, and discovered the essential oils that were to give access to the notes that produce modern perfumes and fragrances. These essential oils in fragrance terms were analogous to the first dyes that man discovered, that led him to produce paintings. Fragrances are the paintings of the perfumery industry.

Essential oils occur in a variety of sites in plants. They occur mainly in flowers such as in Rose, Jasmine, Ylang-ylang, and many other rarer ones. They also occur in wood as in sandalwood, pine and cedar. They also occur in roots, as for example in vetiver, in the barks as in cinnamon, and levang, in leaves as in the cases of mint, basil, citronella, lemon grass, and bay, in



Coriandrum sativum

the seeds as in cumin, fennel, cardamom, and coriander, in the berries as in pepper, and pimento, in stems and buds as in clove, and even in the nuts as in nutmeg. So essential oils can be located in nearly almost every site of the plant material depending on the case. It is one of the widest distributed groups in nature.



Cananga odorata (Ylang-ylang)



Peeling Bark of Cinnamon



Ginger plant

Chemical Nature and Constituents.

Essential oils are steam volatile. This property is used to isolate them from the plant material. It also distinguishes these oils from the so-called fixed oils, or fatty oils, such as coconut, olive or palm oil. Chemically they are quite

different too. The fixed oils contain long chain Fatty acids. The essential oils on the other hand are mixtures of chemical entities of a variety of types. Each essential oil has a characteristic mix of a variety of compounds ranging from a few, to a hundred, and sometimes more. The oil of wintergreen is an exceptional case in that it has a single compound methyl salicylate, which is present almost to the extent of a hundred per cent. Cardamom oil on the other hand has over a hundred compounds all of which to varying degrees must contribute towards the flavour of the spice. The dominant class of compounds in essential oils is the class known to chemists as the Terpenoids. These compounds are widely distributed in the plant kingdom, and they are diverse in chemical character. However they are bound by a common origin. All of them can be considered to be derived by the combination of units of a chemical compound called isoprene, containing five carbon atoms, or simple variants of isoprene.

Thus the class is made up as:

Monoterpenes:

Two isoprene units or ten carbon atoms.

Sesquiterpenes:

Three isoprene units or fifteen carbon atoms

Diterpenes :

Four isoprene units or twenty carbon atoms

A further level of complexity comes as a result of the fact that the terpenoids exist as their derivatives, alcohols, hydrocarbons, aldehydes, acids etc. There is another dominant class of compounds in essential oils namely the phenyl propanoids. These too exist in the form of various derivatives. So essential oils are indeed complex chemical mixtures, What is characteristic in each, is the pattern of the combination.

Modern analytical methods, such as Thin Layer Chromatography, and Gas Liquid Chromatography, enable us to determine this combination as a "finger print" pattern. So, analytical chemists now have a sensitive tool to identify, study the composition of, as well as quality control essential oils.

Industrial Uses of Essential Oils.

Essential Oils find use in a variety of modern industries, primarily as flavouring and fragrance materials. They are rarely used in the naturally isolated form. Usually they are further processed or "rectified" to generate the isolate or fraction that is most characteristic of the fragrance

Sometimes the major compound in these essential oils is used to generate, by synthetic modification, derivatives that are of greater utility. Sometimes synthetic analogues or compounds with comparable Organoleptic characteristics are employed where economic considerations render the natural product more prohibitive in use.

The major industries in which essential oils are used are the following:

Adhesives:

Plasters, fixing agents, adhesive tapes, surgical goods etc.

Automobile Industry:

Coatings, Upholstery materials, Paints etc..

Pharmaceutical & Nutraceuticals:

Medicines, OTC products, Toiletries, Pomades & Balms,

Plastics and Coatings:

Paints & Varnishes, Toys, Household Utilities Furniture.

Insecticides and repellents:

Sprays, De-odorising agents,

Rubber, Leather, Plastics, & Textiles:

Fragrance agents

Paper, Printing, & Packaging:

Inks, fragrant paper materials, Adhesive tapes, etc.

Petroleum:

Cream deodorants, Oils, Greases, Waxes & Special BP Distillates

Foods & Beverages:

Flavours and fragrances

Methods of Quality Assessment

The methods for the assessment of quality in essential oils used in the fragrance industry can be classified into several types as follows:

- * Organoleptic Methods or Methods based on Sensory Evaluation.
- * Physical methods
- * Chemical Methods
- * Methods based on Instrumental Analysis, & Separation Techniques.

The final assessment of quality in essential oils within industry is almost always based on judgments made on the combined data from all of these methods.

Sensory Evaluation or Organoleptic methods

In order to evaluate an essential oil by these methods there is one singular pre-requisite and that is the trained nose of a perfumer. Such training is difficult to obtain for one must possess the natural feature of a sensitive and discriminating nasal faculty, coupled with a memory that can recall odour characteristics. Then there is a systematic training that is required and a build-up of experience. Time and considerable effort is needed to make an effective perfumer. To the experienced nasal faculty of such a perfumer the pattern of evaporation of an essential oil smeared on a smelling strip of filter paper over a period of time, can yield information:

- * About the source of the oil.
- * Its age and condition.
- * Its main constituents
- * Any added adulterants.

The assessment is carried out at intervals, such as:- soon after dipping, one, two and six hours after dipping, and after 18-20 hours later. The responses are frequently compared with what have been deemed to be authentic or acceptable samples. Several persons forming a panel of experts perform this subjective judgment, and, a statistical assessment of the results, is made to give a correct final evaluation. This is however supplemented with the data from other methods.

Physical Methods

The physical methods normally used in the evaluation of the quality in Essential oils include the following:

- * Estimating the content of moisture.
- * Determination of the specific gravity. (use of a Pycnometer)
- * Determination of the optical rotation. (use of a Polarimeter)
- * Determination of the Refractive index. (Use of a Refractometer)
- * Determination of the residue on evaporation.
- * Determination of the Freezing Point or Congealing point.
- * Determination of the Solubility in a diluted alcohol.

Chemical Methods

The chemical methods used in assessment of the quality in essential oils include the following:

- * Determination of compounds with specific chemical functional groups: Such as esters, aldehydes, ketones, phenols, organic acids, etc. such as is relevant to the essential oil under review. The "acid value", "carbonyl value", "ester value" are some of the often stipulated requirements in QA/QC monographs.
- * Determination of specific constituents known to be present in the oil under review. Some examples are: Cinnamaldehyde and Eugenol in Cinnamon Bark and leaf oil, anethole in anise oil, carvone in caraway seed oil, cineole in cardamom oil, rosemary and sage oils, Geraniol in eucalyptus, and citronella oils, and Citral in lemon grass oil.

Methods based on Instrumental Analysis and Separation Techniques.

These constitute an array of slick modern techniques that have revolutionized the quality assessment and control methodology since the 1970's. They are reliable, non-subjective, and repetitively applicable, give reproducible results, and are the most reliable. In the days when quality arbitration is also common in the trade these are of paramount importance but with the proviso that competent personnel handle them and the methods conform to the standards set by organizations such as the ISO. They are:

Chromatographic Methods

- * Column Chromatography (CC)
- * Thin Layer Chromatography (TLC), Densitometry.
- * Gas-Liquid Chromatography (GLC)
- * High Pressure Liquid Chromatography (HPLC)
- * Medium Pressure Liquid Chromatography (MPLC)
- * Super-critical Fluid Chromatography (SFC)
- * Size Exclusion Chromatography (SEC)

Spectrophotometric Methods

- * Ultra violet and Visible range Spectrophotometry (UV-VIS)
- * Infra Red Spectrophotometry (IR)

Spectroscopic Methods

- * Mass Spectrometry (MS)
- * Nuclear Magnetic resonance Spectrometry (NMR)

Techniques such as the above are frequently employed in combined fashion such as GC-MS, GC-IR, LC-MS, depending on the case.

Column Chromatography

Column Chromatography was once the method of choice if the oil is available in reasonable quantity for testing and where some constituent has to be isolated for identification. However it seldom nowadays comes into application in the quality assessment of essential oils as there are more facile techniques. However sometimes one is confronted with the need to carefully examine the oxygenated constituents of a given essential oils and there comes a need to separate them from the hydrocarbon constituents. CC is then a most useful tool to do this.

Thin Layer Chromatography

Thin-layer chromatography is a simple yet versatile tool in that it can reveal a pattern of constituents in the form of an array of spots which can give considerably useful information in regard to an essential oil. Hence it still finds almost routine use in many laboratories. A variation in the form of multi-dimensional TLC is also often in use. Coupled with a densitometer where the spot area and density is assessed it becomes an even versatile quantitative tool. It is a quick method and is therefore often a laboratory favourite.

Gas-Liquid Chromatography

Gas-Liquid chromatography is the technique of choice in the quality assessment of essential oil quality. It seems tailor made for this natural product, since all essential oils are volatile, and contain anything from a few to a few hundred constituents, all in varying proportions. However the hardware represents a considerable investment. Yet if one has to make such quality assessments on a regular basis and in conformity with standards specification in the modern milieu such hardware is an absolute requirement. Any laboratory committed with the quality control and assessment of essential oils needs to be provided with an ensemble of

TLC and GLC at a minimum.

The principle of GLC when expressed simply is as follows: The essential oil is volatalised at a high temperature after injection to the injection port of the Gas Chromatograph, and the volatalised oil is led by a stream of inert gas, like Nitrogen, into a long coiled capillary column. The column is packed with a liquid phase absorbed as a thin film on a support phase (stationary phase). The column is in a oven chamber where isocratic and temperature programmed conditions can be achieved. The constituents of the essential oil mixture are then separated on the basis of the relative differences of the partition coefficients of the components between the two phases the stationary phase and the moving gaseous phase. Components which have less affinity for the stationary phase are eluted first. The elution is monitored by means of a detection, generally of the flame ionization type (FID); and the consequent, numerous peaks, resulting from the detector are indicative of the number of components as well as the relative concentrations of them. It is a sensitive and reliable method of analysis now routinely employed with respect to any volatile compounds.

Sometimes columns packed with material on which a stationary phase is impregnated, are used. These are called packed columns and require a different type of detector based on measurement of thermal conductivity. (ie. a TC Detector). An advantage here is that the eluting gas can be led into a stream-splitter, where one stream goes into the TC detector, and the other can be sniffed and organoleptically evaluated and identified by the nose of a trained perfumer.

Combination Methods

Combination techniques such as GC-MS and GC-IR and others, are used in more sophisticated fragrance laboratories. These require comparatively heavy investment in instrumentation, and well trained technicians.

Conformity with Industrial Standards

For the well known essential oils of commerce, specifications in regard to quality have been identified and drawn up by authoritative organizations. These include national standards organizations and international or regional ones. One of the most important of these is the International Standards Organisation in Geneva or ISO. It has published standards for quality of

all commercially traded essential oils. The classical monographs published by the Essential Oils Association of the USA are somewhat dated, but is a useful source of reference information in regard to standards and specifications. A nine volume set of data sheets published by the FEMA, the Flavour and Extract manufacturers Association is another such classical work that can be useful in the assessment of quality in essential oils.

The Research Institute for fragrance materials (RIFM), and the Fragrance Materials Association of the United States (FEMA), have published safety information on over 1500 raw materials used in the Fragrance & Flavour industry.

Besides these, the International Fragrance Association (IFRA) and the International Organisation of the Flavour Industry publish regularly updated information on safety limits of essential oils and aroma chemicals in a "Code of Practice". Material belonging to the classification GRAS (generally recognized as safe), are listed in the FEMA GRAS List. The Pharmacopoeias and Food Chemicals Codex provide details of Essential Oils used in the Food and Pharmaceutical industries in the form of Monographs.

The International Federation of Essential Oils & Aroma Trades (IFEAT) has published guidelines for the classification and labeling of essentials for transport and handling. Within the countries themselves standards specifications are available, and trade should by law and obligation conform to these. The Sri Lanka Standards Institution (SLSI) has also published standards specifications for essential oils.

Conformity with identified standards is a *sine qua non* for trade success.

As in the case of most commodities malpractices are observed in the trade with essential oils. For example adulteration with synthetics is commonly observed. Often these can be detected by the instrumental analytical techniques but crime as always keeps pace with scientific developments.

Storage & Packaging.

Essential oils are a sensitive commodity being liable to easy contamination from the air, from unclean containers, and from transformations caused by oxidation, hydration, and heat. Accordingly storage of essential oils once they

have been prepared according to strict scientifically optimized protocols must be stored to prevent deterioration, even after long periods of storage. They are preferably stored in cold rooms with control of temperature and away from sunlight.



The ISO has set out general guidelines for storage and transport in trade and these are to be strictly followed in order to establish successful trade relations.

ISO recommendations for containers are as follows:

- * **Metallic containers.**
These should be such as casks, drums, barrels, or cans; they should be in sound condition and new, clean, dry and fabricated with tin or enamel or aluminum lining, or coated with a resistant lacquer. For essential oils not in use in the food or beverages industry similar iron containers with tin or aluminum lining or copper plated iron, galvanized iron, or sometimes enamel painted containers may be used.
- * **Glass containers.**
These are ideal but should be absolutely protected from possible breakage during transport and shipment. Light sensitive oils should be contained in darkened containers.
- * **Plastic containers.**
These could be used provided that they are inert to the particular essential oil they are to contain. They too should conform to the requirements set out for metal containers, and ensured against rupture or breakage.

ISO recommendations for closures.

The recommendations for closures are as follows:

Cork, Glass, Aluminum, tin or other material which has no effect on the product. A tamper proof seal on the closure should also be provided.

Oils that contain phenolic constituents such as cinnamon leaf oil, clove oil, react with metals such as zinc while oils that contain a preponderance of Monoterpenes react strongly with aluminum. Accordingly the producer must be aware of the characteristics of the oil that is to be stored and shipped.

The containers should be well filled, preferably with a stream of an inert gas used to displace the traces of oxygen that may be present in the residual air above the oil level in the filled container. (Generally, the headspace must be no more than 5-10% of the total volume of the container.)

There are also specifications in respect of labeling, and these should be followed as well as any others recommended by treaty between seller and purchaser.

The Goal of Total Quality Management.(TQM).

The supreme objective in the essential oils industry, like in all herbal products industries is a difficult one, namely that of Total Quality Management. The difficulty lies in the fact that it commences with a starting material which being a biological natural product has its dimension of variability. It is not an easy task to establish and maintain TQM. The ISO 9000 series of international standards includes requirements for quality management systems aimed at achieving common interpretation, implementation, and application of a documented quality management system. It is therefore important that a producer company meets the requirements of ISO standards 9000-9004 as well as ISO 14000. Most companies therefore seek certification of their quality management system from an accredited authority to ensure that they are regarded as a acceptable supplier by clients worldwide.



In Memoriam - Dr. Peter Tetenyi

The Digest records with deep sadness the passing away on February 26th 2009, at the age of 83, of: Prof. Dr.Sc. Biol. Peter Tetenyi, one of the world's greatest authorities on Medicinal and Aromatic Plants.

Tetenyi, an individual of considerable charm, was a researcher with the Institute of Medicinal Plants, Budalalasz, Hungary, for over half a century and was Emeritus Director of the Institute. He was a pioneering name in his field, and was associated with several international Institutions such as: the Royal Academy of Pharmacy, Barcelona, the National Academy of Pharmacy of France, and the International Society of Horticultural Science (ISHS).

He was also on the panel of UNIDO consultants in the Programme on the Industrial Utilization of Medicinal & Aromatic Plants, and his work in Rwanda especially was well recognised.

He had a prolonged battle with illness but passed away peacefully. He was laid to rest in his family burial ground on March 11th and, according to a family member, "in the midst of orchids, accompanied by the organ music of Bach, and by the notes of the Symphony of Destiny and the Overture of Tannhauser"

Tetenyi belonged to the Hungarian nobility, and had wide cultural interests too. There is a large duchy in Hungary still called Tetenyi, of which he in old times would have been the Count. But there was none other than simplicity in the man himself, the only hint of nobility being his regal bearing and cultivated tastes and manners.

He was a dedicated colleague and a splendid team-individual whom the author admired much when associated with him. His wife Magda, was also a brilliant scientist as were his sons Peter jnz, and Tomas.

To all of them go out our sincere condolences, as they, and the world have lost a great scientist and a fine human individual.

R.O.B.Wijesekera

See also Digest vol 3, 2007, pg.05:
Celebrated Researchers No.3.

Technology Variations in the production of essential oils

By R.O.B.Wijesekera



An Old Distillation Still made of Copper.
Picture from the Fragonard Museum
in Grasse, France.



Peeling Cinnamon Bark



Clove trees in a home garden in Sri Lanka

1. HISTORY OF ESSENTIAL OIL PRODUCTION

There indeed is evidence that the production of essential oils is as old as history itself. When one examines the fact that perfumery was an established art during the days of the zenith of Arabian culture, it is surely clear that the technique of steam distillation was very well known. There is evidence also that distillation was known to the Indus valley civilisation during the Mohendo Daro period. Deriving from the method of production of essential oils, one can define essential oils as:

"the steam distilled essence of the fragrance materials of plants" - and here one includes every possible part of plants - for essential oils are found in flowers, in leaves, in roots, in gums, in fruits and seeds and often in the whole plant itself.



Cinnamon bark Quills



Cardamom



All-Spice = Pimento



Ginger



Coriander seeds



Cymbopogon citratus = Lemon grass



Peppermint

The fragrance industry during medieval to modern times, has seen a variety of techniques in the production of materials of natural origin, and when in industry the term, "Natural Fragrances" is used, that mainly covers all essential oils, aromatic extracts derived from vegetable matter, and even extracts derived from animal secretions.

Several process variations and several technologies are involved in the manufacture of natural fragrance materials today. These processes have been developed to satisfy various different needs. Therefore when one talks of essential oils today, one uses it as a generic term, or rather, one uses natural fragrance materials as the generic term, and this involves the following products of the industry:

Essential oils; steam distilled or cold pressed **Concretes**, which are fatty waxes saturated with aromatic substances, and derived from the extraction of plant material using solvents. **Absolutes**, that are an alcohol-soluble liquid or semi-liquid, saturated with an aromatic substance. This is very often produced by extraction of the absolutes with alcohol. **Resinoids**, an alcohol or benzene direct distillate.

L-CO2 distilled Products.

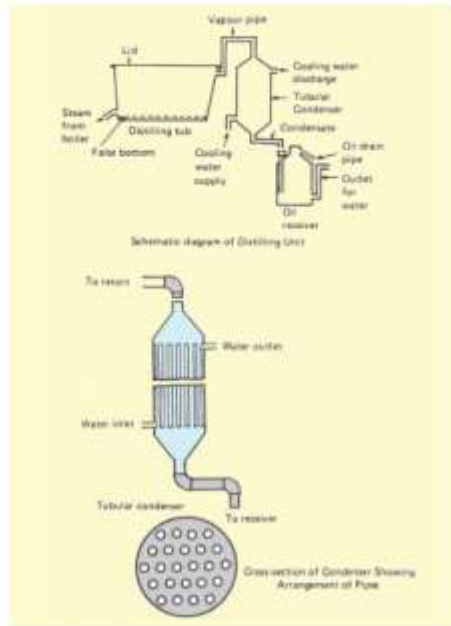
Let us take the aspects of all these technologies, their evolution through the ages, the various types and modifications that they take in various parts of the world, and see for ourselves the tremendous variety and the great variations that the technology takes .

Undoubtedly, one would have to spend a great deal of time, relatively speaking, on the technique of steam distillation, because this is the oldest and most widely applied technology, and this is the technology that will remain as the most substantial methodology for extraction of essential oils in industry for a long time still to come

THE GAIA HYPOTHESIS.

The goddess Gaia provided the name for the hypothesis of the radical English scientist James Lovelock who in 1979 introduced the Gaia Hypothesis into the sedate earth sciences. It stated that the earth is a colossal living self-regulating organism
J. Lovelock: Gaia - A New Look at Life on Earth, Oxford University Press 1979.

2. PRINCIPLES OF DISTILLATION USING VOLATILITY IN STEAM



The principle behind steam distillation, quite simply stated is this:

the individual constituents of the essential oil, (although they each may have boiling points higher than water,) form constant boiling mixtures with the water, which boil over at a temperatures much less than that of water, ie. Less than 100 degrees.

Accordingly, distillation, using the property that the aromatic essential oils are steam-volatile, can take three basic forms:

- * Water distillation, which is where the plant material is boiled in water and the distillate collected and allowed to separate into different phases,- the aqueous and the oil. This technique is still preferentially applied today in the case of, for example, cinnamon bark.

The other variations depend on the degree of contact of the steam with the vegetable material.

- * Water and steam distillation, which merely is, the generation of the steam within the still body itself.
- * Direct steam distillation when the steam is introduced into the still body after being generated in a separate steam boiler.

These three techniques vary in themselves based on their application, their dimension and their degree of sophistication. It is

employed all around the world. So here, one may have a look at some of these variations. But before that, let us look at the basic components in terms of the technology, of what steam distillation means. It includes:

- * a Still Body, or Tub into which the plant material is loaded.
- * a Boiler or source of heat which generates steam either outside the still body or within the still body itself.

The passage of steam through the plant material in the Still Body causes the cell walls of the oil containing cells within the plant material to rupture, and thereby release the oil. Then the steam volatile components volatilize, and form a vapour equilibrium mixture with the steam, and therefore can distil over, as stated before, at temperatures far lower than their individual boiling points. The volatile material that comes over is then condensed by the use of Heat-exchangers of various types.

- * The Heat-Exchanger is the next important component of the equipment assembly.

Within the heat exchanger the vapour mixture is condensed and led into a vessel which acts as the means of separating the oil from the aqueous layer.

Heat Exchangers are generally of two types:

1. The Coil-in-Water type which is the oldest. This is simply a coiled tube immersed in a tank of water.
2. The multi-tubular type which is a cylindrical casing containing several tubes through which the distillate mixture passes. The stream of cooling water passes between the tubes and the casing. The latter is more modern and has several advantages over the coil-in-water type, chief of which is that there is no reverse pressure in the distillate chamber.
- * The Florentine vessel, or Oil Separator, is the next component of the distillation assembly.

These separators are basically of three types. viz: vessels designed to separate oils that float on water, vessels designed to separate oils heavier than water and therefore sink to the bottom and form the bottom layer of a water oil mixture. Then there is a combination-type separator which is used for certain oils which have components that are heavier than as well as components that are lighter than water, and therefore you would have two layers, one layer that is floating on the water and one layer of oil at the bottom. And this means that the two oil layers have to be separated, and combined

together to give the authentic essential oil that is related to this material. As mentioned earlier, Cinnamon bark is an example where the most basic technique of boiling in water is often used.

In this instance, the traditional concept is that other techniques are less efficient and not known to



A small-scale modern steam distillation Assembly. In front the Florentine vessels, and on top the Heat Exchanger, open-ended to display the multi-tubes.

give acceptable yields on an industrial scale. However there is no doubt, that steam at high pressure can also be well used in a modern and controlled distillation unit. Such more modernized units are indeed used in good factories. However in the parts of world that the larger amount of cinnamon oil is distilled from fresh cinnamon bark, the technique is used is generally water distillation.



Modern Distillation Still



A multi-tubular Heat exchanger



A modern extraction assembly

The methods of water and steam distillation are often used in the distillation of essential oils that are derived from the grasses that is plant materials of Graminae species. They are such common things as lemon grass or citronella grass and palmarosa grass, and even the oil derived from leafy materials such as those of the labiatee - the mentha varieties, or Thymum, Basil, Geranium etc., or even the distillation of cinnamon leaf, bay leaf or clove leaf oils.

These oils are not among the most expensive from the point of view of per unit volume price but nevertheless are important commodities of commerce and are used in the fragrance industry to obtain certain characteristic compounds which are combined to make the flavour and fragrance materials that are desired. The distillation of these materials can involve simple large scale Field Stills, where a common steam boiler generates steam that is passed into the main still body. The still body is usually a cylindrical type of body where as a general feature the diameter to height ratio is 2:3 and the older varieties have a characteristic swan-neck type of lead which leads the vapour into a condenser. The more modern type has done away with this swan-neck type of lead. They just have

a normal direct lead pipe to the condenser. The condensers or heat exchanger also shows variation. The two basic types of condensers that are used, as indicated heretofore, are the shell-and-tube type of condenser which is the most efficient; or the most usual and simple to construct type, the coil-in-water condenser. Whatever are the variations, certain circumstances, particularly in drought stricken regions have demanded the conservation of water, whereupon two variations of condensers are used.

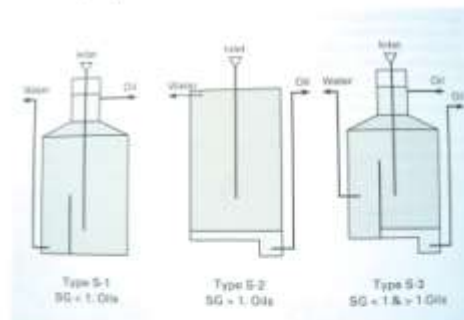
One is an innovative air cooled condenser. Undoubtedly, one cannot judge the air condenser in efficiency, in comparison to, for example, a shell-and-tube condenser, but of course it uses or requires far less water. In a situation where there is plenty of raw material ready for harvesting in the field, like lemon grass or citronella grass, but there is no water during a drought, where the streams have dried up, the rivers have dried up, and water has to be transported for long distances, then you might as well use the air-condenser of this type in order to ensure that some at least of the essential oil is distilled and obtained. This has been successfully achieved in Sri Lanka in the Southern regions during the 1970.s when there were such needs. There was plenty of plant material then, but drought had set in. The farmers were hard pressed to reap the just reward of their labours. The air-cooled condenser identified in the field as the "Manakoka" proved invaluable. An improvement swiftly introduced was the combination of a latent-heat exchanger with an air-cooled- condenser or to use the principle of latent heat exchange in a coil-in-water condenser.

These are all possible or relevant in the case of field distillation in remote areas, in difficult terrain where the essential oils are usually grown and particularly used in the distillation of grasses, leafy materials, which are usually carried out in the growing areas, and where rural folk do the growing, the harvesting, and at times even the distillations.

There are some variations in still designs from place to place, from region to region. Innovative changes are noticed. For example, you could have two still bodies connected to a single condenser system, either used together or used in series, in other words one still can be loaded while the other still is cooling off.

Another more sophisticated technological variation is the use of two still bodies mounted on a truck. This is used in large farm areas where several kinds of essential oil bearing

species are cultivated. This device facilitates harvesting and collection of the raw material. The still body in the form of a housing is mounted on a truck and the truck is driven along the areas where harvesting has been completed and ready for collection into the truck which houses the still body. This type is employed in large farms, obviously, multi-crop farms, and the truck can be driven to the location in which a, particular essential oil bearing plant has been harvested. The harvested material which does not need any drying, is then loaded into the still body mounted on the vehicle and when it is full, the truck is driven straight into a central place where there is a steam boiler and a condenser-cum Florentine vessel outfit. The truck is positioned and the connection from the steam boiler to the still body and the still body to the condenser system is made. Distillation can then proceed and once the distillation is over, the still body is detached, the truck is driven away and after discharging the distilled material, is ready for recharging. A second truck with a similar still body could be immediately brought into position and thus several distillations can take place in a day. The photograph depicts such a truck with a distillation unit used in the Fundulea farm, in Romania. It is common to find in many parts of the world, in Asia, in parts of Eastern



Diagrammatic Representation of Florentine separator types

Europe, in the Mediterranean regions, in south Southern France, and in other parts such as Latin America, quite ordinary looking still bodies, functioning right in the farming areas where essential oil bearing plants are grown. These still bodies are no more than those in which the traditional type distillation is carried out, and the quality of the oil is unquestionably good and so is the yield. Quite obviously, the distillation time and economics of such distillation equipment is also acceptable so that it is a

perfectly inexpensive, economically and technically feasible technology for obtaining the essential oils from the field site itself. Such stills are eminently suitable for location in developing countries, in many regions of the world, where distillation in the field, is carried out as a commercial operation, in order to make use of a commodity that is cultivated on a very large scale. The practice is to install a battery of five or up to 10 or 12 still bodies connected to a central condenser system, or attach a condenser for each still body where the advantage is that depending on the raw material available one could always use from a single to up to 12 still bodies. So the load can be varied according to the availability of raw material. The steam is generated through a single boiler and the water from a single source runs through the condensing unit. The distillate from all the still bodies passes through individual Florentine flasks, from which the separated oil is then pooled. There are advantages and disadvantages in systems such as these but these seem to be the practice for example in the clove oil distillations in the "Spice islands" of Zanzibar and Pemba.

These large distillation units charge up to about between 350 to about 500 kilograms per still body of clove stem or clove bud. The raw material is an expensive commodity. These islands produce such an enormous quantity of it, that rapid distillation in a central facility is extremely necessary. So as soon as the post-harvest preparation is complete, the clove stems, as well as the buds are conditioned by gradual sun drying and air drying. Actually a combination of the two operations takes place, because the sun shine is really about 10 hours/day or less and then the rest of the time it is dried in the open. This renders the material into a state where there has taken place, not only a removal of moisture, but, a kind of curing operation where certain further flavour development reactions are also known to take place *in situ*. The stems and buds are distilled separately to generate clove bud oil and clove stem oil, two related but commercially different oils.

The distillation units are worked in such a way that the oil that is generated is stored for export and there is a continuous use of raw material that is purchased from individual farmers. Management of the distillation is crucial to commercial success.



A battery of Stills installed with a multiple condenser system for large-scale distillation (Clove Oil Distillation Factory, Pemba, Tanzania)



A motorized Still Body that can be transported along the site of cultivation and the harvested material collected en route, and finally brought to a central location for distillation by connecting the flexible steam connection, (Fundulea farm Roumania. At left is Dr. Emil Paun)



A primitive version of the technology



A Modern Field Still designed and fabricated by Eisseric of France and located in Nepal.



A double-bodied Field Still in Viet Nam for the distillation of Basil.



A "Nomadic" type of Field distillation Unit. It is used by Tribes in Irian Jaya for distillation of Eucalyptus Oil.



The celebrated unique Manakoka still designed by the CISIR in the 1970's, to combat drought periods

3. SOLVENT EXTRACTION OF FRAGRANCE MATERIALS

Solvent extraction is also a method that is very much used in the production of essential oils. In former times, there used to be a practiced method that was known as "enflourage". This method was used particularly for the extraction of the delicate essences of flowers like, Roses and Jasmine. The petals of the flowers were placed on trays which contained thin layers of semi solid Vaseline. They were allowed to lie as such for days. When it was considered that the Vaseline was saturated, the Vaseline was then partitioned with a solvent such as methanol in which it is not miscible. The fragrance material was then absorbed by methanol and the methanol evaporated to give the fragrance essence. There is one great draw-back in this technique in that the Vaseline should have been extremely pure and odourless. It was a laborious process to execute and slowly this process has given way to extraction with low-boiling solvents. This is done in an extractor which consists basically of a static extraction vessel in which the raw material is placed then covered with food grade organic solvents such as hexane or sometimes benzene or even toluene.

The temperature of the solvent varies according to the nature of the raw material and is usually no more than 75 C. The duration of the extraction and the number of possible successive extractions, (that is the number of possible successive solvent runs through the extraction vessel), also varies from one raw material to another. After the extraction is complete, the solvent containing the aromatic substances, or "The miscella" is pumped into a concentrator or reboiler,

where the solvent is removed at the boiling point of the solvent. When the volume is reduced, to about a tenth of the original volume, this final 10% of solvent is removed under vacuum distillation. To do this it is put into a vessel called a finishing concentrator or a vacuum reboiler and the final is the resulting "concrete" product. The concrete generally resembles a fatty waxy-semi-solid, depending on the temperature.

There are instances such as in lavender for instance or in lavandin, where the concrete is rather liquid and in the case of rose or clary sage, it is almost solid. The concrete contains not only the aromatic substances but also certain natural waxes and pigments that are present in the raw material. In general the concrete is usually quite stable at ambient temperatures.

Sometimes it is necessary to obtain the fragrance material in an aromatic plant in the form of what is known as an "absolute", that is, an alcohol soluble, liquid, or semi-liquid oil, saturated with the fragrance component of the aromatic plant. This is because frequently, perfumers like to use the fragrance material in the form of an alcohol soluble solution. Perfumers sometimes require solutions and extracts that are soluble in alcohol particularly for use as colognes. Waxes are insoluble in alcohol at low temperature about i.e. -1 C. Therefore concrete is diluted in alcohol at ambient temperature or little above ambient temperature and thoroughly shaken. When this solution is cooled to -5 C to 10 C, the waxes precipitate as insoluble material which can be filtered off by means of a filter or by absorption, and the filtrate is concentrated under vacuum in order to get rid of the alcohol. What remains is called the "absolute". Absolutes are generally in liquid form but may vary in density from the very viscous to the more mobile material.

Another category of frequently encountered products are called: "Resinoids". Resinoids are obtained by direct extraction with either alcohol or, even hydrocarbon solvents; removal of the solvent generates the viscous material which is called "resinoids", and such extracts in the case of spice extracts are called "Oleo-resins". It is customary, when this is done on a very large scale to use a resinoid extraction unit, which in reality employs the floating filter extractor. This is a system where the extraction vessel contains the raw material and solvent and above it the floating filter and by means of a pump the solvent saturated with the extractive or the miscella is drawn out and introduced directly into the concentrator or reboiler system. Under

pressure, the alcohol or other solvent is removed, and what is left i.e. the Oleoresin or Resinoid, is led out of the base of the concentrator.

4. RECENT INNOVATIONS IN TECHNIQUES AND EQUIPMENT:

Since the early days of the production of essential oils, the variations in technology depended upon the variables, such as:

- * the use of steam with varying degrees of dryness,
- * the pressure surrounding the vegetable material that was to be distilled being either less than, equal to or higher than the atmospheric pressure;
- * The vegetable material being in direct contact with steam producing water with a water steam mixture or with the steam only.

This is basically the extent of variation of the process of steam distillation.

Also in the traditional processes, the mixture of the steam and the Vaporized volatile constituents of the oil are pushed upwards from the bottom to the top. This method is what is commonly known as the method of hydro-distillation or water distillation.

Recently, a process due to Schmidt Hydro-diffusion SA-Switzerland, involved the converse, direction of distillate flow; in other words the steam is introduced at the top of the still body and condensed at the bottom of the still body, and the process has been called "hydro-diffusion". This process is known to give essential oils with very special characteristics and also with variable economic parameters. The innovators of this new technology claim that the physical chemical or chromatographic characteristics that are generally included in the national or international norms for essential oils may not exactly be met by the essential oils produced by this technique, and may appear to be as a border line case with respect to these existing norms.

It is also stated that the boards which formulate pharmacopeias and essential oils standard specifications should take this into consideration. There undoubtedly appear to be some advantages in the technique.

The distillation unit itself looks like a parallelepiped-like enclosure, divided into superposed compartments.

The upper one presents a sliding wall fitted to the drawer which can be loaded with the vegetable material. This drawer sits along the rails of an adapted support for joining the extraction enclosure. The grill closes the bottom of the drawer. The steam is introduced on the top of the extraction enclosure by means of a perforated steam distributor and the mixture of essential oil vapours with water pass down to the lower cooling partition through the raw material and the grill constituting the bottom of the mobile drawer. The condenser is made from the pipes connected to the cool water supply. The condensate is recovered at the base and conducted towards a decanting device.

Steam is fed through an independent boiler, the pressure not exceeding 6 bars. The steam is saturated and expanded at 0.02 - 0.15 at the inlet valve.

Some of the advantages claimed for this technology is of course economy, shortened duration of distillation time for a variety of raw materials, including 4 hours for cinnamon bark and cedar wood bark, - times ranging from 1.5 hours and below to leafy materials such as basil, citronella, eucalyptus, lemon grass, palmarosa, 4 hrs. for patchouli and 1/2 hr. for lavender, lemongrass - lavandin, 3-4 hrs for cardamom and 4-5 hrs for nutmeg, black pepper, and so on. The yields are of course variable. However the steam consumption is recognized as being less than in the case of a parallel usual steam distillation. A note of caution has to be expressed because the yields of essential oils may sometimes include lower melting fatty material that could break down from the vegetable material into the distillate and so there may be an apparent increase of the yield. The equipment itself presents other advantages apart from the advantage gained from the product. The facility of operation, the lateral opening system of the extraction slides together with the loading drawer pivoting grill for instantaneous discharge without pulleys or any type of system to lift the marc-containing basket. It reduces time from one batch to another thereby enabling several distillations to be carried out within a given period of time. The obvious drawback is that this technique is not best used where there are low boiling fatty materials in the essential oil or where there would be low boiling or easily soluble materials which can clog in the equipment.

5. EXTRACTION WITH LIQUID CARBON DIOXIDE.

One of the relatively controversial, recent methods is the method of extraction with carbon dioxide. The advantages of this method are the following:

1. No residual solvents remain as a result of incomplete distillations such as in cases of a solvent extractive material from odours sensitive flowers.
2. It is a low temperature process and of significance when processing material that is relatively unstable or sensitive.
3. It has important selectivity.
4. It is non-inflammable and relatively energy saving.

The main disadvantage is that the oil obtained must be of a different character to that of established oils that are produced by steam distillation, because, these constitute components that are the results of artifacts, by hydrolysis or trans esterification whose odours contribute to the collective odor which characterizes each essential oil.

The second disadvantage and one that is very significant to developing countries is the prohibitive cost of the initial capital outlay and the cost of the solvent. However, 3 or 4 extraction parameters can be varied in accordance with the desired product.

Sometimes liquid carbon dioxide or supercritical CO₂ is used, that is at more than 1071 p. s. i. pressure, 31 C. By changing the pressure and temperature parameters, the characters of extracts will change. Carbon dioxide extraction is expected to be a major process of natural aromatic raw material extraction for flavour and fragrances in the industrial countries, in the years to come. But whether it can take over the bulk of natural essential oil production globally is a moot question. In the operation of the method, to the charge of vegetable matter carbon dioxide is added, pressure and temperature inside the vessels are regulated according to the manufacturing process developed. Saturated carbon dioxide is pumped into the separator vessel in which the pressure and temperature are lower than in the extraction tank. The product is removed and the remaining carbon dioxide pumped back into the charcoal trap tank to be purified and recycled.

Several examples of commercial oils extracted by this method are known and they present an interesting variety judged by the fact that they are normally extracted by a very different route. Most of all this method is eminently suitable for the extraction of delicately flavoured oils such as Jasmine and Rose, and other sensitive flavours.

6. RECENT IMPROVEMENTS IN OIL SEPARATION

Methods of extraction are not the only operations in the production of essential oils that have in recent times received the attention of research workers. One very important operation is the recovery of the essential oil from the oil/water mixture. Many essential oils and particularly those containing phenolic substances are relatively soluble. Long periods of standing of the water discarded after the first separation is the means used for saving the dissolved essential oil. This method is used in the distilleries that produce sandalwood oil and vetiver oil two very expensive oils. Sometimes the water which is finally discarded contains sufficient odour characteristics that it is used as bath water. In the case of sandalwood this is common in the distillation regions.

A new and sophisticated method for recovery has been developed recently by Fleisher and this method uses the principle Frontal Liquid chromatography. The distillate water flows continuously through a column packed with blocks of porous Poly Tetra-Fluoro-Ethylene (PTFE) which retains on its surface, about 20% width, volume for volume of low boiling water immiscible organic solvent. The saturated solvent is periodically replaced by fresh solvent without stopping the process. The time after which the solvent in the column is saturated can be calculated from data such as H.E.T.P. (i.e. Height Equivalent to a Theoretical Plate), the distribution co-efficient of the most polar constituent of the oil-in water mixture. Preparation of the liquid phase support in blocks provides stability and efficiency for the large diameter columns (Columns of diameter ranging from 200 to 400mm). The H.E.T.P. is about 20 to 50mm. Use of PTFE excludes the possibility of any changes in the oil composition as it is a very inert material. This new method is an improvement on a straight forward liquid-liquid extraction.

Although it is based on similar principles, the extraction of the oil components takes

place when the distillation water passes through the column with low polar organic solvent distributed on the internal surface of this porous inert material. The process itself resembles more liquid-liquid frontal chromatography with modifications to make it suitable for high efficiency, industrial scale separation of essential oils from distillation water. The set up of the equipment system is relatively simple. The pump feeds the distillation water into the column after its passage through a filter, where it is purified from the usual solid particles. Prior to the introduction of the distillation water into the porous support, the latter is wetted by a definite volume of the organic solvent to be utilised. The distillation water is then passed through the column, and after the solvent is deemed saturated - (that is following the passage of a definite volume of water), a valve is switched by a timer to the solvent line, and a new measured portion of fresh solvent is now introduced into the column. The introduction of this fresh portion pushes the saturated portion out of the column and takes its place on the support itself. The eluted liquid, that is, the solution of the essential oil in the solvent, and the distillation water-free-from-oil -components form two layers in the separator, from which the solution of the essential oil is periodically removed. The pure essential oil recovered from the distillation water is obtained after trapping solvent by convenient methods. This method is however of limited value in the case of developing countries although perhaps very useful for expensive oils.

AN "EARTH DAY" PERSPECTIVE

"Once we calculate the full and real cost of synthetic fragrances today we suddenly see that whole botanical essences, in which Nature has processed and compounded the chemical components herself, are not as costly as we once thought....."

The oncoming generation unfamiliar with naturals would find that fragrances based exclusively on synthetics would be accepted because people would not know the difference."

John M. Steele - Co Author of EARTH MIND published by Harper & Row

Essential Oils & Daily Lifestyles.

Ayesha Tanya

The utilisation of essential oils and their derived products in our daily lifestyles the world over is ever on the rise. The Flavour and Fragrance industries alone count a turnover of over several million dollars. There are also more humble uses of essential oils in the majority of the countries of the third world where they are mostly produced. The count in terms of money alone is far from significant. The need is to safeguard the plant species that render to humanity such valuable service and to discover the value of others species as yet unknown. There is an R&D ideal to be addressed in this.

Counting the Uses.

The uses of essential oils in daily life may be briefly recorded as follows:

Cleansing of the Atmosphere.

In ancient societies this was almost a daily ritual. The use of incense is one that has come down the ages and although reserved for ceremonial occasions daily practice of this is well known. The use of essential oils as fragrance sticks (Agarbathis, or Handung Kurus), is well established as a custom in the countries ranging from central Asia through south and south east Asia to the far east. In ancient Egypt and indeed even in the entirety of Arabia the practice of cleansing the atmosphere was well known. It was even followed to the grave where the Pharaohs were embalmed with essential oils, as revealed in the researches following the excavation of tombs.

Cleansing of the Body.

Bathing in fragrant waters has always been a popular practice. In ancient India and indeed in the Indus valley civilizations the practice was conducted even by ordinary folk. They were able to utilise the discarded waters after the distillation of sandalwood oil for bathing. The fragrance remains on the body for a long time. The practice prevails to this day in the regions where sandalwood is plentiful. In southern and Eastern Europe lavender is used somewhat in

this fashion. In Turkey and Bulgaria where there is a comparative abundance of Rose oil similar practices where the rose water is used to cleanse the body abound.

In modern times scents of various kinds are added to water for inhalation, steaming of the face, and for inclusion in baths.

The modern use of perfumes and deodorises also derive from this practice.

Scenting of Linen and Clothes.

This practice though modern would undoubtedly have had roots in antiquity. Essential oils such as Lavender, Sandalwood, Lemon grass, Citronella oil, Vetiver oil, and Geranium Oil, to mention some, are used as additives to soaps and detergents to render the washed materials fragrant. The oils used have a component which has a lasting and persistent odour albeit a gentle and acceptable one.

Spraying of the Atmosphere

Again, this is a practice that has its beginnings in antiquity when flowers were used to render a room or a hall with a pleasant smell. This practice finds wide modern usage. Scented sprays are used in public and private places, in offices hospitals and industrial plants. The psychological effect of a pleasant odour in a work place encourages good working relationships between people and this is now beginning to be recognised.

The practice finds wide use in the aero industry where long flights, with passengers crowded within a confined atmosphere, cries out for freshness.

Hand and Foot Baths

Soaking hand and feet in warm baths which contain added essential oils albeit a few drops at a time, are a useful remedy to combat limb weariness. Ayurvedic practices which use aromatic leaves and twigs in a hot bath is the probable precursor of this practice. Such practices are a part of Chinese traditional medicine as well.

Massage Oils

Massage oils are made by adding 10 to 20 drops of an essential oil onto about 30 ml of a "carrier" oil, such as coconut oil, jojoba oil, sesame oil or olive oil. This too is an old practice and possibly originated with the Hindu culture in India where an "oil bath" was a family ritual. Today such massages are modern practice and aromatherapy is practiced worldwide.

Hot & Cold Compresses

Hot and Cold compresses are used for handling sore limbs and inflammatory conditions. Inclusion of a few drops of an essential oil in the compress works wonders in helping the healing process. After a heavy exercise schedule, such compresses are a great relief. They are also wonderful treatment for painful inflammatory conditions.

Decongestant

Many essential oils act as decongestants and give prompt relief. Eucalyptus oil is one of the most frequently used because it is relatively inexpensive. Most of the "balms" contain blended essential oils in a paraffin or wax base. The essential oils open up the nasal passages and bring comfort during a heavy cold.

Combating Nausea

Nausea is a condition frequently encountered by many, during travel or following a tiresome day. Essential oils bring prompt relief. Oils such as Peppermint Oil, Lemon grass oil, are some of the best.

Infections

Many essential oils are now known to possess antibacterial and anti-inflammatory properties and are used as such. Tea Tree oil, Cinnamon leaf oil are two of them and conditions such as acne, pimples and simple infections can be treated by gentle application of these oils with a carrier oil. There are many pharmaceutical preparations with this as the base.

Summing Up

Essential oils are generally far too concentrated to use as such. Only Lavender oil and

Tea tree oil are used directly sometimes. Essential oils are always used in the wide variety described heretofore, diluted suitably with an excipient suitably chosen. They are a boon to modern society just as they have been throughout the centuries. Modern pharmaceutical practice has found new methods to utilise their full value. The practice of Aromatherapy is a significant chapter on its own where essential oils are employed for a multiplicity of conditions. (Vide: LNP Digest. Vol: 3 issue 1 page 07)

TEA & SAMAHAN - FOR FATIGUE & JET LAG.



Known since colonial times as the "Cup that cheers" new scientific evidence has shown the reasons behind the invigorating influence of the popular beverage. After a lengthy flight air passengers have often proclaimed that the inevitable weariness is overcome by a hot cup of tea. Recently passengers on flights returning home to Sri Lanka have vowed that a dose of Samahan - Link's flagship remedy for the common cold - is also a welcome remedy for the fatigue and "jet lag" that follows a long flight. The welcome news now, that flights are becoming longer and longer, is that a combination of the revered beverage and Samahan is a prime answer to the discomfiting aftermath of an aerial journey, - or for that matter may be any exhausting trip. Somehow the cup of tea with Samahan seems to serve the purpose of both a welcome beverage as well as an antidote to fatigue, as well as jet lag. There appears to be a mutually synergistic effect enhancing the benefits of both. So instead of merely Tea and Sympathy it becomes Tea and Samahan.

Try it! And feel for yourself the difference.

Medicinal & Aromatic Plants gathered from wild Resources. - Some Salient Issues

By VIKRAMA

Introduction

It is a worldwide phenomenon that the larger portion of medicinal and aromatic plants used for therapeutic needs are derived from the spontaneous flora. This is true of the developing world as well as for the industrial nations. As a result of this phenomenon, and doubtless as a result of the resurgence of natural plant-derived therapeutic agents, as well as personal care products such as perfumes, many medicinal and aromatic plants have been endangered. This has even led to some species being rendered extinct. In an attempt to arrest this alarming trend several responsible international agencies have contrived to develop safeguards and have issued a document listed as:

AN INTERNATIONAL STANDARD FOR SUSTAINABLE WILD COLLECTION OF MEDICINAL AND AROMATIC PLANTS (ISSAC-MAP). Version I 2007

This document is the combined work of the Medicinal Plant Specialist Group (MPSG) of the Species Survival Commission (SSC) of the IUCN-World Conservation Union. It has been prepared on behalf of a Steering Group consisting of the Bundesamt für Naturschutz (BIN), = (the Federal Agency for Nature Conservation), the MPSG/SSC/IUCN, the WWF Germany, & TRAFFIC.

This document is available in full (38 pages) from: <http://www.floraweb.de/map-pro/>

The publication is included in the literature database "DNL-online". www.dnl-online.de.

Background to the Document.

This document is a most welcome one and although it is specially directed towards the European Community, it is timely because of several important factors:

- * Several plant species in the tropics in particular, are now on the IUCN red list as endangered species. These include such

species that are regularly needed to supply the therapeutic requirements of Ayurvedic medical practitioners.

- * Even at present there is wild ransacking of the sources to serve short-term mercenary interests. This applies to such Heritage sites such as the "Singharaja Forest" in Sri Lanka.
- * Plant species required for Ayurvedic therapy are rapidly joining the extinct list in Sri Lanka, India, and even in countries such as Nepal Tibet and Vietnam.
- * The outlook is tragic if not promptly regulated and the management placed on a sustainable basis.

Therefore the document referred to above comes at a time when it is crucial to educate those in the business as well as to bring to focus the role of the regulatory authorities and governments of the consequences of neglect.

In the document the ISSC-MAP builds on the recent efforts to define a framework for the sustainable use of biological diversity. It is designed to assist those involved in the harvest, management, trade, manufacture, and utilization of medicinal and aromatic plants collected from the spontaneous flora or in other words forest resources. Those involved need to understand and adhere to the conditions under which sustainable collection of plant resources can take place.

The ISSC-MAP also responds to the need to use biodiversity resources for the benefit of human health and wellbeing by contributing to the objectives and targets defined by the Millennium Development Goals (UN 2005), and the Johannesburg World Summit on Sustainable Development.(2002).

More specifically the document focuses on:

- * The recommendations of the 1993 WHO/IUCN/WWF Guidelines on the Conservation of Medicinal Plants.
- * The WHO Guidelines on Good Agricultural and Collection Practices (GACP) for Medicinal Plants 2003

The document aims to assist government agencies, private companies, research organisations, Universities, and community organisations to identify and follow good practices for the following six key elements:

1. Maintenance of wild resources of MAP.
2. Prevention of negative environmental impacts.
3. Compliance with laws regulations and agreements.
4. Respecting customary rights.
5. Application of responsible management practices.
6. Application of responsible business practices.

One might from the point of view of developing nations like ours also add the seventh, and that is:

7. Respecting traditional knowledge and practices.

Rationale for the Document

It is recorded that between 50-70 thousand species of plants are used by the peoples of the world as therapeutic agents, both in traditional systems as well as for modern medical usage. (Schippmann et al 2006). About 3,000 species are traded globally as medicinal and aromatic plants. (Lange & Schippmann 1997), while an even larger number of species are traded regionally, and locally. Very few species are cultivated systematically for any purpose and the large majority are collected from the wild. (Lange & Schippmann 1997, Srivastava et. al. 1996, Xiao Peigen 1991)

It is noted that this trend is likely to continue over the long term due to factors such as the following:

- * Lack of knowledge about the agricultural practices required for each of such a large number of species of MAP.
- * The time, research, and experience needed for domestication and cultivation are costly and the market capacity can scarcely support and ensure stability to bring in the investment needed.
- * MAP species are cultivated in poor communities and land and resources are scarce.
- * There are competing situation like alternative more lucrative crops.
- * Natural and pest infected disasters hit eh farmers hard.
- * Venture capital is hard to come by for MAP which has a high risk factor.

Securing the MAP material from the

wild is often a simpler option for poor rural folk seeking a subsistence level living only. However, over-harvesting, land conversion, and habitat losses are a threat to wild species. It is reckoned that 15,000 species or 21% of the world's MAP are in danger.

The challenges for the application of good practices are identified in the document as the following :-

- * Circumstances of ecology, habitat and pressures on resources are unique for each species, requiring management plans that are specific to each MAP collection and area of operation.
- * The dependence of local communities on MAP resources for health and livelihood security a factor that is largely not assessed and not recorded as such.
- * Little research on harvesting technology has been directed towards the collection of MAP species from the wild in a sustainable manner.
- * The maximum quotas for wild collection of MAP species are based on overly simple and untested assumptions about the relationship between available supply and regeneration of the MAP resources.
- * Products, uses and markets based on the resources of MAP resources, are numerous and diverse. This gives rise to diverse entry points for practices supportive of sustainable use.
- * There is a wide proliferation of labels and claims, such as organic and fair trade, which implies, but does not provide a means of verifying if the plant material, was collected from the wild in a sustainable manner.
- * Long and complex source to market supply chains make tracing a product back to its source extremely difficult.

Existing principles and guidelines for sustainable collection seem to address primarily the international and national political level. Only indirectly do they provide the stakeholders namely, industry, governments and local bodies with specific guidance on correct sourcing practices and related technologies. For example such documents as:

1. Guidelines on the conservation of Medicinal Plants (WHO/IUCN/WWF/TRAFFIC) -forthcoming and
2. WHO Guidelines on Good Agricultural and Collection Practices (GACP) for Medicinal Plants - 2003. WHO.

Can and do provide general recommendations addressed to governments, and other stakeholders NGO's, IGO's, and Industry & business. These guidelines do not however, provide concrete principles and criteria for the sustainable use of MAP.

The ISSC-MAP document it is claimed provides a practical interface between the general recommendations set out in the above guidelines, and the management plans that must be developed for particular species and particular situations.

The Scenario in the Developing World.

This document will be of immense value to the sophisticated industry of the industrialised nations and will enhance and guarantee quality of material in the trade. However in the context of the developing nations which indeed are major stakeholders in the trade, and industry, the document ISSC-MAP will perhaps be of little practical value, at the field level. What is needed is, if that were possible, to derive from the principles a concise practical manual on the sustainable harvesting, preparation and storage of MAP species derived from each spontaneous source. Some initiative in this direction was implemented by UNIDO in Nepal during the 1980's when the methodology of the Rumanian scientist Ovidor Bojor helped with an economic mapping of the wild flora of the Himalayan region. (Bojor 1991)

In the context of countries such as Sri Lanka one notes as follows: (2008).

Over 65% of the MAP species used in traditional medicinal processing is derived from sources of the commercial trade and comes from outside the country.

Medicinal plant species vary in their requirement of climatic and growth conditions, and also in the time of maturation of the crop. A carefully derived plan of cultivation for a circumscribed region is a prime need, to supplement the withdrawal of plant material, and this will be the best of supportive methods for sustainable harvesting from the wild. It will be up to the local authorities to fund the research to enable such a manual which matches species requirement with supply needs to enable agro-initiatives to commence.

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THE NECTAR OF GAIA & THE GENESIS OF PERFUMERY

GAIA was the ancient Greek Goddess of the earth. Perfumery is the art and craft that developed from the use of the Nectar of Gaia - that portion of the Earth's Fragrance created by living plants. Aromatics has always been an integral part of our history evolution and belief systems. Until the 20th century perfumery was based entirely on the Nectar of Gaia.

REALM OF THE GODDESS

Witchcraft is based on an even more ancient Paleolithic and Neolithic worldwide tradition which preceded patriarchal societies. The Goddess who was known by many names in many cultures depicted the biological life cycle of women : the young virgin maiden, the pregnant mother, and the wise old crone. This in turn was based on the three phases of the moon: waxing, full and waning. It was the goddess of Earth that empowered the eternal cycle of Birth, Life, and Death, and regeneration of Life in nature.

Christine Malcolm in Perfumery & Flavorist : (1990) vol 15, 13-22.

STEVIA - "Sweet Herb of Paraguay" *Stevia rebaudiana* Bert., (Compositae),

By R.O.B.Wijesekera

"Sugar is sweet my love but not so sweet as you"



Introduction

Sugar as is commonly known is one of the most popular food additives. It comes to the table in a purified crystalline form, from two main commercial sources viz: Sugar cane and beet. Sugar cane is cultivated in the tropical regions while beet is commonly nursed in the more moderate climates of Europe. Brown sugar arises when the cane is burnt prior to harvesting to facilitate the harvest process. It drives away reptiles and other harmful creatures which may harm the cane cutters who manually harvest the cane by cutting it with a cutlass. Also some contamination with molasses renders the sugar brown which gives a characteristically attractive flavour. The brown sugar called "Demarara Sugar" comes from the cane cultivations of Guyana by the banks of the river Demarara. Chemically sugar is known as Sucrose, which is a disaccharide. It consists of two simple monosaccharide units, or single sugar units, Glucose and Fructose.

The human body utilizes sugar as its simplest form of energy. It gives the body the required calories. Sucrose occurs naturally in plants, particularly in fruits and vegetables. It is thus a part of a healthy person's natural diet. In modern times sugar appears to have taken on a villain's role, and is incriminated as a causative factor in several diseases notably diabetes mellitus. However according to the landmark FDA Report of Sugars Task Force of 1986 sugar when consumed on moderate quantities cannot be linked to many disease, or even dependency. Nevertheless this does not condole over intake of sugar. The fact that sugar is contraindicated in cases where there is reason to suspect flawed metabolism such as when the person is prone to diabetes or other condition is quite another issue.

Nonnutritive Sweeteners as Sugar Substitutes

It is this issue, of the contra-indication of sugar intake in cases of diseases such as diabetes, which has given rise to sugar substitutes, which are termed "Nonnutritive Sweeteners". Of these, Saccharin, for example, is 300 times sweeter than ordinary sugar but has no nutritive value or calories. An FDA sponsored study conducted by the National Academy of Sciences (NAS), showed that Saccharin could be a cancer causing agent in humans. This caused a mandatory labeling to indicate its possible long term danger in all products containing saccharin.

Another such sweetener is Aspartane, which is about 200 times as sweet as sugar and has a comparable amount of calories. This too has certain restrictions as some people cannot tolerate the amino-acid phenyl alanine, which is a constituent of Aspartane.

Others like cyclamate have been banned by the FDA. So a viable substitute for sugar was a desperately needed item in the context of modern living and in the scenario that there were indeed people with flawed metabolism and even an inherent preference for sweetness.

The Sweet Herb of Paraguay

Worldwide, there appeared to be a clear demand for alternative sweeteners.

It is in this context that the "sweet herb of Paraguay" came into focus. The herb *Stevia rebaudiana* Bertoni, produces in its leaves just such an alternative, with the added advantage that stevia sweeteners are natural products. It is 300 - 400 times as sweet as sugar.

In addition the steviol glycosides which are the sweetening agents, possess functional and sensory profiles superior to many other high potency sweeteners. As a result stevia is likely to become a major source of high potency sweetener for the expanding natural food industry. For this need it will be necessary to convert stevia from a wild grown crop to a plantation crop and to domesticate it in regions other than its present habitats.

Botany, History and Cultivation Practices

Stevia rebaudiana Bert., is one of 154 members of the genus *Stevia* and one of two that produces sweet steviol glycosides.[1,2,3].

It is native to the valley of Rio Monday, up in the highlands of Paraguay, where it grows in its natural habitat of sandy soils beside streams. It has a history of having been used by native tribesmen for centuries.

It also grows in southern Brazil. It was brought to the notice of the Europeans in 1887, when M.S.Bertoli learnt of its unique properties from the Amerindians of Paraguay. It was first set into commercial cultivation in Paraguay where it came into use as a sweetening agent. Later a large attempt at cultivation was initiated by the Japanese. Presently stevia accounts for about 40% of the consumption of sweeteners in Japan. Since then stevia has been introduced to as a plantation crop to several countries including: Brazil, North and South Korea, Mexico, the U.S., China, Tanzania, Indonesia, and since 1990 into Canada and India.[4]. Currently the production of stevia is largely in China with Japan as the major target market. Most of the patents for the process technology for production of *Stevia* from the leaves of the plant are in Japanese hands.

Stevia is a small shrubby perennial growing up to between 45- 65cm tall. With sessile, oppositely arranged lanceolate to oblanceolate leaves, which are serrated above the middle. The flowers are small and white and arranged in an irregular cyme. The seed is an achene with a feathery pappus. *Stevia* is an obligate short day plant with a critical day length of around 12-13 hours. However extensive variability within populations in regard to the length of day sensi-

tivity has been recorded and so adaptation is a real possibility.

Crop production & Propagation.

Stevia plants could be propagated either from seed, or vegetatively from cuttings.[2] The method used in a given situation will depend on largely economic factors. Production of stevia as an annual is often the chosen methodology. Seed based propagation commences with green house grown seedlings, which are then transplanted into the field. The crop has to be irrigated for best results.

Planting densities vary greatly and range from 40,000 to 400,000 plants per hectare as tried out in Japan, and more recently in Canada. The length of daylight has a bearing on the quantity of sweetening agent in the leaves. *Stevia* is harvested just prior to flowering when the leaves are deemed to contain the highest yield of sweetening agents. The leaves are harvested, separated from the stems and dried prior to processing. The total sweet glycoside content can reach up to or over 20% in the best varieties.

In a recent introduction in India it is reported that three harvests were possible during a twenty four month growing period. [5]. The following steps in the production of stevia are significant:[6]

*** Harvesting.**

The harvesting is initiated when about 5% of the flowers have begun to open. This is the stage at it is estimated that the highest content of the sweetening agents are present. The plants are cut about 10 cm above the ground level. About 5% of the plants are left un-harvested in order to generate seeds. It is estimated that one worker per 1000 square meter of land would be needed for harvesting. The land has to be irrigated for the first two weeks following the harvest. The second harvest can commence 70-90 days following the first. The yield obtained will be of the order of 4000kg per hectare per year. The plantation will require re-plantation after.

*** Drying of the leaves.**

About a 100 square meters of drying surface will be needed per week and more on rainy days. Use of synthetic fabrics for the drying surface is recommended. The twigs and branches of the harvest will shed the dried brittle leaves after being exposed for about 6-8 hours of sunlight.

The leaves are then easy to separate for processing. The drying process can be conducted using mechanical or fluidized bed drying techniques such as are used in the drying of tea leaves.

*** Storage of the leaves.**

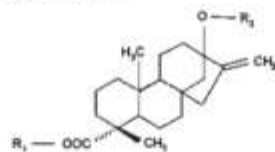
The leaves which when dry are dark green in colour are stored in bags (10Kg/bag) made of porous material. The store rooms must be dry and free of humidity. Air conditioned rooms are recommended for storage until processing.

Chemical composition of Stevia

There are a number of reviews that describe the chemistry of the sweetening agents of stevia.[5,7,8,]

The main compounds responsible for the overall sweetening properties have been outlined by Cramer and Ikan as in Fig 1.[8]

The main diterpenoid glycosides which are responsible for the sweetness being the most abundant are stevioside and the rebaudiosides A, B, C, D and E.



Diterpenoid glycoside	R ₁ ^a	R ₂ ^a	Boiling points (mmHg/20°C)
Stevioside	H	gl ⁻¹ -gl ⁺	190-225
Rebaudioside	gl ⁻¹	gl ⁻¹	190-225
Rebaudioside	gl ⁻¹	gl ⁻¹ -gl ⁺	190-200
Rebaudioside A	gl ⁻¹	gl ⁻¹ -gl ⁺ -gl ⁺	210-430
Rebaudioside B	H	gl ⁻¹ -gl ⁺ -gl ⁺	190-200
Rebaudioside C (rebaudioside B)	gl ⁻¹	gl ⁻¹ -gl ⁺ -gl ⁺	190-225
Rebaudioside D	gl ⁻¹ -gl ⁺	gl ⁻¹ -gl ⁺ -gl ⁺	210-430
Rebaudioside E	gl ⁻¹ -gl ⁺	gl ⁻¹ -gl ⁺ -gl ⁺	190-200
Dulcoside A	gl ⁻¹	gl ⁻¹ -gl ⁺ -gl ⁺	19-120

^a In D-glucopyranosyl ester form (Cramer and Ikan, 1987).

Of all the sweetening constituents of stevia, stevioside and rebaudioside have been well characterized with respect to their Organoleptic or sensory properties and stability. They are both stable. Besides the sweetening agents there are a number of other chemical constituents such as steroids, polyphenols, diterpenes, flavanoids and terpenoid compounds which may come in as industrially important in the future when their availability becomes enhanced, as byproducts of commercial scale production of stevia.

Commercial Scale Extraction

Most of the commercial scale processing takes place in Japan and the methods are covered with a dozen patents. There are basically two different approaches one based on solvent extraction and others based on separation methods. The most favoured approach according to Phillips involves the following main steps:

- * Aqueous or solvent extraction
- * Ion exchange separation
- * Precipitation or coagulation.
- * Filtration
- * Crystallisation
- * Drying.

Processing technology, on a smaller scale, to generate crystalline steviosides, or even extracts for direct use, have been developed in India, China and North Korea. In the latter case they are introduced into soft drinks directly.

Concluding Observations

Stevia represents a new opportunity for the countries which do not have the traditional crops such as cane sugar and beet sugar, and therefore have to spend large sums of money in acquiring this necessary food item. It also represents an opportunity to combat diseases caused by excessive sugar intake, which are now on the rise, and yet enable those suffering from them to enjoy sweeteners and the quality of life of normal persons. It is also a challenge to farmers to domesticate profitably a tropical plant for which cropwise cultivation methods have to be devised.

Stevia sweeteners have a long history of usage in South America, and now in Japan too, and there are no reports of any adverse effects. Nevertheless there has been some controversy in regard to its ant-fertility effect which has not been substantiated. This controversy may have been initiated in competing commercial lobbies and can therefore be discounted.

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IMITATORS OF SUGAR'S NATURAL SWEETNESS

Ayesha Tanya

There is a worldwide interest and an industrial demand for substitutes for sugar in products that are ordinarily consumed by many. The products we consume range from soft drinks, confectioneries, to candies, chocolate products and chewing gums. This is largely due to the prevalence of diseases such as diabetes and the negative health effects associated with the high consumption of sugar.

Recent market surveys confirm that products sweetened with sugar substitutes are enjoying considerable market success. The 2008 edition of Millward Brown's Top 100 most valuable Brands, cites Pepsi products including diet Pepsi and Pepsi Max at having a current market value of no less than 15 billion US dollars. Coca Cola products and their low calorie variants, rated the most popular brand of soft drinks are valued at a staggering 58 billion dollars. It is interesting to note that both these company's now use the new sugar substitute: "Aspartame", which can be regarded as derived from a natural product, as opposed to being totally synthetic. The latter type is associated with other disease conditions.

What then is Aspartame? It is derived from a natural source namely a cereal like wheat or maize.

There are no sweeteners that can replace beet sugar cane sugar completely, that are derived directly from natural sources. Stevia, from the plant *Stevia rebaudiana*, (described in detail elsewhere in this issue of the LNP Digest),

is the closest option. However isolation of Stevioside or Rebaudioside from the plant material, also brings in the intervention of technology and there are patent encumbrances to counter. For that matter similarly simple technology intervenes even in the production of sugar from cane or beet.

There are however, newer substitutes that have now emerged that find extensive use in large scale production of very popular products consumed worldwide. Aspartame is one such product that is now one of the most popularly used by leading companies. It was introduced into Europe in 1982. At that time sales of low calorie carbonated soft drinks stood at no more than circa 390 million litres. By the year 2007, driven by the low sugar incentive it had soared up to 7.2 billion litres. That represented an 8% growth as compared to the growth of regular carbonated drinks which stood for the same period of time at hardly 0.5%. In several sectors of the Food and Beverages industry that has been surveyed, the choice of market leaders for a sugar substitute to meet the growing demand has fallen on Aspartame. Aspartame is made from two amino acids that occur widely in the food that is normally consumed. It is easily assimilated by the body without any complications. However there still are some concerns regarding the overall safety of aspartame and controversy shadows it.

Another such popular sugar substitute now gaining in popularity is "Maltitol" a product made by Roquette, and brand identified as Maltisorb maltitol. It can be substituted for sugar on a one to one basis and its worldwide usage extends to biscuits, chewing gums, chocolate products, and ice creams. Its versatility in simulating the features of sugar is well established by the fact that it gives the same responses, the same mouth feel, sweeten characteristics, after taste, and cooling effect as sugar with less than a half of the calories. It also displays very similar physical characteristics to sugar which include solubility, stability, hygroscopicity, and viscosity. This makes it a boon to process technologists who are not called upon to make any changes in their process protocols. Maltitol is made from wheat or maize. Starch is extracted from the cereal and broken down to maltose syrups in a process that is similar to the "mashing" process in the manufacture of beer. The maltose is then converted to maltitol, which is made available as a syrup, or a crystalline or granulated material.

Source : Cosmetics & Toiletries

The Digest Mail Bag

Letter 1

The Editor
Link Natural Products Digest.

I have read with great interest the Link Digest a copy of which I got from a friend. I think the Journal is valuable from the standpoint of a lay reader interested in the science behind herbal medicine. It will also serve as a good teaching Tool. University students should be encouraged to dip into your website and read the digest.

James Lovelace
Irvine, California USA

Letter 1

The Editor
Link Natural Products Digest,

May I offer you my congratulations on the continued excellence of your publication,

Dr. Matt Watson
Canberra, ACT Australia

NOTE TO POTENTIAL CONTRIBUTORS

Link Natural Products Digest

The DIGEST is a popular publication, albeit a scientific one, dedicated to medicinal plants, herbal healthcare and personal care products, essential oils, aromatherapy, herbal therapy and Ayurveda, and related healthcare systems. It is published bi-annually.

The DIGEST welcomes contributions in English in the category of reviews, brief communications, ethno reports in brief, phytomedical and phytochemical communications, book reviews, and reports on safety and efficacy of phytomedicines.

Potential authors may consult the Editor-in-Chief prior to dispatch of communications, reports and reviews.

Authors may submit manuscripts by post or e.mail to :

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Please forward to the editor one original hard copy and a soft copy in the form of a PC compatible diskette (Microsoft Word).

All manuscripts must include the following :

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