ABSTRACT OF THE WORK DONE

In the present work entitled, "Studies on Indian Aromatic and Medicinal Plants", thorough chemical examination of the seed lipids of Butea monosperma and Solanum xanthocarpum and the essential oil of Xanthoxylum alatum as well as pharmacological investigations on the essential oil Xanthoxylum alatum have been done. Nutrition studies on the Butea monosperma oil have also been carried out.

The total lipids of Butea monosperma and Solanum xanthocarpum seeds were extracted with chloroform: methanol (2:1) solvents. They were subjected to methanolation and the overall fatty acid composition determined by GLC. The total lipids were separated into hydrocarbons, steryl esters, triglycerides, free fatty acids, sterols and mono and diglycerides and polar lipids by elution chromatography over silica gel and the distribution of fatty acids in each class studied by GLC. The composition of the unsaponifiable matter was found out by GLC and the individual constituents identified by IR spectroscopy.

The total lipid content of Butea monosperma and Solanum xanthocarpum are 19% (W/W) and 1.6% respectively. Out of this 1.05% and 1.81% are constituted by unsaponifiable matter. No conclusive evidence for alkaloids could be obtained in Solanum xanthocarpum seeds.

It was found out that triglycerides formed the major lipid class in both seeds. The polar lipids had a high percentage of saturated fatty acids in Butea monosperma. Hexadecanoic, docosanoic and tetra-cosanoic acids are mainly present in the saturated fatty acids of Butea
monosperma whereas these are considerably less in Solanum xanthocarpum. Good amounts of oleic and linoleic acids were found in both and an unusually high percentage of linolenic acid is found in Solanum xanthocarpum seed lipids.

Sitosterol, 3 keto-β-sitosterol and campesterol were identified in the unsaponifiable matter of Butea monosperma. Solanum xanthocarpum contained only sitosterol. Small amounts of hydrocarbons and polar constituents were also found to be present in Butea monosperma.

The volatile oil of Xanthoxylum alatum was obtained by hydrodistillation. After preliminary separation of the oil into hydrocarbons, oxygenated compounds and more polar compounds by elution chromatography over silica gel, individual constituents of these fractions were obtained by column chromatography and preparative GLC, and identified by ultraviolet, infrared and mass spectroscopy: d-limonene, citronellal, linalool, methyl-nonyl ketone, dihydrocitral, citral, nerol, geraniol and methyl cinnamate were found in the oil.

Since the Butea monosperma oil contained high percentages of essential fatty acids, nutrition studies were performed to test its usefulness as dietary fat. Young rats were fed on a fat-free diet mixed with 10% Butea monosperma oil for three weeks. The weight gain and the normal cholesterol content of blood and liver of these animals showed that this oil could be used as a source of dietary fat.

Pharmacological studies of the essential oil and its major constituents named methyl cinnamate and linalool were carried out. It was found that the essential oil in lower doses caused depression and reduced the spontaneous motor activity of mice, but at higher doses
produced hypnosis in both rats and mice. When administered alone, neither methyl cinnamate nor linalool caused any hypnotic effect but a combined treatment of these two produced hypnosis, the duration of sleep being comparable to that caused by the oil. The oil also potentiated the hypnotic effect of pentobarbitone sodium. It also lowered the rectal temperature of mice and was also an effective analgesic in rats. The oil exerted a local anaesthetic effect in mice, blocked the conditioned avoidance response of rats and showed anti-convulsant property.
SCOPE OF THE PRESENT WORK

The earliest recorded history speaks about the formulations of medications from plant and animal sources. Interestingly Shen Nung, Chinese scholar and emperor of the 28th Century B.C., compiled a book of herbs and observed antifebrile action of the plant Ch'ang Shan which is now known to contain antimalarial drugs (Bonner and Castro, 1967). Thus the exploration of the plant kingdom for chemical compounds of medicinal value has been going on for thousands of years and herbalism and folk medicine, ancient and modern, have been the source of much useful therapy. During the nineteenth century organic chemists took up the study of many plant principles, the physiological effects of which have been recognized. Although the structures of the many vegetable drugs are now known, there is still plenty of scope for finding new and useful drugs in two directions. One of these is to study the synthetic analogues of known drugs and the other to serach for new drugs in plant species not yet investigated.

The present problem "Studies on Indian aromatic and medicinal plants" was undertaken along the second line of approach. About fifty different plants to which are ascribed some uses in the indigenous Indian medicine were investigated and had to be discarded either because of the very low percentage of the required consitutents or because some of them did not survive the screening and pharmacological study.

Finally the following seeds were chosen for chemical and pharmacological investigation.
1. *Xanthoxylum alatum* (Rutaceae) - essential oil
2. *Solanum xanthocarpum* (Solanaceae) - lipids
3. *Butea monosperma* (Papilionatae) - lipids

THE STATUS OF MEDICINAL AND AROMATIC PLANTS TODAY

**Medicinal plants**

Research into medicinal plants proceeds mainly along three lines: study of the species and genera of plants related to those already used in medicine; checking the experience of folk medicine, and exhaustive chemical investigation of flora for the presence of biologically-active substances.

Work along the first line of research made it possible to replace some foreign medicinal plants with home species. Checking the experience of folk medicine is often made difficult by the exceptionally wide range of medicinal applications of the species of plants used and the absence of precise diagnostics: the plants are often used as symptomatic remedies - "to alleviate headaches", to "cure stomach disorders" etc. As a result, checking of folk prescriptions often demands much labour and by no means are their properties pharmacologically and chemically substantiated (Shreter and Krylova, 1969). The third line has produced notable results. An especially thorough study has been made of the distribution of alkaloids soon after the discovery of reserpine in 1953 from Rauvolfia vomilorea.

The study of Indian medicinal plants as a possible source of anti-cancer drugs has been in progress for four years. It has been carried out in collaboration with the United States Public Health
Service. Laboratory tests, conducted on 800 medicinal plants at the CDRI showed anti-cancer properties in 34 plants (Rajagopalan, 1969)\(^3\). Some breakthroughs and discoveries of far-reaching importance in the field of cancer chemotherapy may come from investigations on medicinal plants. Today two drugs have reached beyond exploratory stage to clinical usefulness. These are the \textit{Vinca alkaloids} and \textit{Podophyllotoxin glycoside} from podophyllum for cancer of the throat. (Atal, 1965)\(^4\).

Pyrrolizidine alkaloids, more than 70 of which have been isolated from the genera \textit{Crotalaria} and \textit{Senecio} have attracted some attention as anticancer agents, though at the present stage they have not been adopted for clinical use due to their hepato-toxic principles (Atal, 1965)\(^4\).

Mainly as a result of mass-screening of plants, Morris Kupcham, of the University of Wisconsin demonstrated tumor-inhibiting properties in several cardenolides. Extracts and pure compounds isolated from \textit{Apocynum cannabinum} and \textit{Alclepia currasavica} have shown promising activity against sarcoma of the naso-pharynx in cell culture (Atal, 1965)\(^4\).

A number of other plant materials have shown some promise as a result of the work done at Indian Cancer Research Center in Bombay, at Chittaranjan Cancer Research Institute, Calcutta, and at the University of Saugor (Gupta and Nigam, 1970)\(^5,6\).

An interesting and new field of research where plants have made a definite contribution is the study of drugs, affecting behaviour. Starting from the discovery of LSD derived from Ergot and the indole alkaloid mescaline derived from the cactus \textit{Lophophora williamsi}, a large number of other plant sources for such drugs have been found.

The ability of certain plants to agglutinate erythrocytes has
been known since the end of the 18th century. In 1948, Renkonen was the first to discover that the agglutinating property of certain plants was blood group specific. Such plants occur mainly in the family Leguminosae, but a few belong to Calastraceae, Solanaceae and Vitaceae. In recent years the seeds of *Laburnum alpinum* have assumed importance in clinical blood group diagnosis. Research in India has shown that seeds of *Doliches biflora* also yield a blood group specific haemoglobin (*Atal, 1965*).

The usefulness of *tubocurarine* as a muscle relaxant and its application in surgery, particularly thoracic surgery, is well known. It was a long way from arrow poison curare to the present day usefulness of *tubocurarine* resulting in the award of the Nobel Prize to two scientists. Work at CDRI has shown that the alkaloid hyatine isolated from *Cissampelos perreira* can act as a good substitute for *tubocurarine*.

Research conducted during the last decade have proved the usefulness of liquorice in the control of gastric and duodenal ulcers, Addison's disease and the inflammatory conditions in dermatology. While the anti-inflammatory action has been definitely ascribed to glycyrrhetic acid, the active principles responsible for other actions are not fully understood. Recent work has proved that a glycoside, liquiritin, and some other flavanoids are responsible for the antispasmodic properties. Madine, an alkaloid recently isolated from *Peganum harmala*, and rutin, a bioflavonoid which in very small doses protects experimental animals against exposure to X-rays have been discovered.

Considerable interest has been shown in newly discovered active principles of Indian medicinal plants. Particular mention may be made of *Jatanansone*, a ketonic principle isolated from *Nardostachys jatamansi*. 
Jatamansone possesses potent and prolonged hypotensive activity in various species of animals and also shows anti-arhythmic and mild tranquilizing properties. Peruvoside, a cardiac glycoside isolated from *Thevetra narifolia* appears to be a safe drug with good oral absorbability and reasonable duration of action. Collophylloid, a complex 4-phenylcoumarin isolated from seeds of *Calephyllum inophyllum* shows anti-coagulant activity ranging between dicoumarol and tromexan and also antiarrrhythmic activity comparable to quinidine, and is thus suggested for use in myocardial infarction.

**Substitutes for pharmacopoeial drugs (Chopra and Handa, 1965)**

A large number of plants growing in India possess properties and actions similar to those of imported and often expensive remedies and thus serve as excellent substitutes. Not infrequently, it is some closely allied species that is pharmacologically just as effective. For instance, *Colchium luteum* from the Northern Hymalayas can be substituted for *C. autumnal*ae, *Scilla indica* for *S. maritima*, *Picrasana quassioides* and *Gentiana kurro* for *P. excelsa* and *G. lutea*, and *Ferula nartex* from Kashmir gives a gum resin like asofoetida. Indian *Rheum emodi* is just as good as *R. palmatum* from China, *Aconitum chasmanthum* is as potent as *A. napallus* which grows in Europe and is not found in India. A number of species of the male fern *Dryopteris* grows abundantly in India and are just as effective medicinally as the *filix-mas* of British pharmacopoeia. *Physochlaina pracalta* from Ladakh contains more than 1.0% of atropine group of alkaloids and is potentially a valuable species for the production of alkaloids. The Indian Pharmacopoeia is now giving
recognition to all such drugs and official standards are being laid down.

A large number of poisonous plants of India have been thoroughly investigated and fully discussed in Chopra's Indigenous Drugs of India, 1958.

Survey work on medicinal and allied plants (Chopra and Handa, 1965)

The materia medica of the Indian system of medicine has been derived mainly from the vegetative kingdom and more than two thousand plants having medicinal properties have been included in the literature. Though early European workers took keen interest in this group of plants, investigations along scientific lines started only half a century ago. Now, a herbarium has been set up in the Regional Research Laboratories, Jammu. It has been possible to collect about 20,000 specimens of all plants with alleged medicinal and toxic properties from about 1800 different species known to grow in India.

Drugs used in Indian indigenous medicine

A description of, and the work done on these plants is given in Chopra's Indigenous Drugs of India, 1958.

Aromatic plants

Since antiquity man has been mystified and intrigued by the aroma of plants and has made great efforts to obtain the fragrant constituents called the essential oils. The word "essential oil" undoubtedly originates from the Latin "quinta essentia" (quintessence), the
fifth element, the essence of things. Alchemists believed essential or volatile oils to be the most condensed form of the individual characteristic of the plant or drug (Sterrett, 1962). Today, as a result of many years of research, these oils have become indispensable and essential to our way of life. They have a variety of applications in almost all industrial and consumer products from rubber, food and toilet preparations to embalming fluids. Essential oils are used mostly for their sensor quality, but also often for their antibacterial and antifungicidal action.

Essential oils contain a variety of substances, the most important of them are the terpenes. The term terpene is currently applied to all oxygenated and/or unsaturated compounds from plant sources which are derived from the molecular formula \((\text{C}_5\text{H}_8)_n\). Terpenes rival carbohydrates, steroids and alkaloids in the chemical interest they have stimulated and many of the fundamental reactions and generalizations of organic chemistry - for example the Wagner-Meerwein rearrangement and Bredt's rule - were discovered during the course of terpene research (Bonner and Castro, 1967). The biological activity of the terpenoids is given under Part D.

**Synthetic oils**

In order to get less expensive products, chemists have developed "synthetic" essential oils as substitutes for the natural products. These consist primarily of two groups of aromatic chemicals. One includes those synthesized economically from petroleum or coal tar derivatives plus some synthetics not known in nature. The other group,
the "isolates", are specific fractions from the distillation of natural oils containing generally one chemical compound in more or less isomeric mixtures e.g., citral from lemon grass oil, pinene from turpentine and linalool from Cois de rose oil. These isolates may also be used as basic raw materials for the manufacture of other aromatic chemicals. For example, citral is converted chemically into ionones, eugenol into vanillin and β-pinene into geraniol, nerol and linalool (Max, 1960)\textsuperscript{10}.

Another refinement in the manufacture of natural essential oils is the preparation of concentrated, "terpeneless", "terpeneless and sesquiterpeneless" oils (Sterrett, 1962)\textsuperscript{9}. By subjecting the essential oils to careful distillation under reduced pressure there are obtained as distinct fractions, the hydrocarbons or terpenes of the oils and an odorous oxygenated portion which remaining behind in the distillation apparatus. The oxygenated or high-boiling fractions retains the odour in a heightened degree. In other words, the oil has been concentrated and the residual valuable fraction is found to have a far greater solubility coefficient in alcohol than the original oil, a fact of considerable commercial importance.

Even though the senses of odour and taste are the oldest senses, the most primary endowment of prehistoric man, research has not yet produced an analytical classification analogous to what we have for white light in the spectrum and for sound in the musical scale. Different mixtures of various essential oils and aromatic exhibit basically a similar odour. The literature reports numerous olfactory researches (Moore, 1960; Thompson, 1957; Amoore, 1952; Beets, 1957)\textsuperscript{11-14} and theories about the mechanism of olfactory stimulation based in the
chemical structure, reactivity, volatility, molecular vibration etc. Questions such as why chemically different substances produce similar odours or why concentration changes of the same chemical compound at times produce opposite odour effects remain to be answered. Perhaps with new instruments and new research efforts we will be able to solve such problems, as well as duplicate in a test tube the natural essential oils of which only very few can be successfully imitated today. The study of essential oils should prove most fruitful, since many interesting problems await solution.