

HISTORY AND THE CHEMISTRY OF HERBAL PRODUCTS IN MEDICINE

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History

The use of plants in medicine dates back to the beginnings of man. Plants being the most abundant and easily accessible, were the first to be tried out in time of sickness. Therefore it is quite understandable how over the centuries plants have made such an important contribution to medicine. The primitive man started to experiment with the plants around him in an attempt to treat injuries and cure diseases. Thus over the centuries, by trial and error, he gradually discovered a number of worthwhile remedies.

As civilization began to develop in Egypt, Mesopotamia, India and China, the therapeutical potential of a large number of medicinal plants were collected and documented. According to one report the earliest documented medicinal plant was Ma-Huang. This plant was first described about 5000 years ago by the Chinese emperor Shen Hung as a remedy for cough and also as a cardiac stimulant. In 1926 European scientists discovered the biologically active compound in Ma-Huang as Ephedrine, which is now used for treating asthma patients. Another report says that early Chinese physicians have used the plant Chang Shang (*Dichora ferbrifuga*) for antifebrile effect and *Artemesia annua* for antimalarial effect. Modern scientific investigations on the two plants mentioned above showed the presence of two very effective antimalarial drugs, Ferbrifugine and Artemisinin respectively.

During the middle ages (11th to 18th century), the widely accepted dogma that nature herself provides a cure for every disease gave added incentive to the search for medicines among the plant kingdom. It was commonly believed that the 'signature' of a disease was impressed upon the plant, which could cure that particular disease. Plants with red flowers were used to prevent bleeding, and those coloured yellow were supposed to cure jaundice. The wrinkled kernel of the nutmeg was thought to resemble the brain and so nutmeg was used to treat mental diseases. The serpent shape of *Rauwolfia serpentina* (Sinhala - Ekaweriya) root commonly called snakeroot indicated that it should be useful in treating snakebite. The worm shaped embryo of Chenopodium or wormseed suggested it to be of value as an anthelmintic.

Natural Products as drugs

Natural products contained in, or derived from medical plants are used in all countries. In western countries medicinal plants provide raw materials for industrial processing and preparation of pure drugs. In many developing countries such as Sri Lanka, extracts of the various parts of medicinal plants are directly used in all forms of therapy. However it is indeed unfortunate that for many centuries very little emphasis has been placed on the scientific aspect of studies on medicinal plants. As the late Dr. John Attygalle has wisely pointed out in his compilation of *Sinhalese Materia Medica* published in 1917 "it is much to be regretted that practitioners of Western Medicine in Ceylon have paid so little attention, if any, to the many useful drugs employed by our native medical men".

The importance of plant-derived drugs in modern medicine is somewhat underestimated. Such useful drugs as quinine (antimalaria) reserpine (antihypertensive), vincalokoblastine (antileukemic), ephedrine (anti-asthmatic) to mention only a few, represent a broad spectrum of medicinal products isolated from plants. In addition to these purified drugs, the crude drugs derived from plant sources (e.g. crushed dry leaves of foxglove - *Digitalis purpurea*

used as a treatment for heart failure) are also utilized by some physicians practising Western medicine. Most of these drugs were discovered as a result of the painstaking research of organic chemists and perceptive physicians who believed that there could be some truth in many of these seemingly "folkloric wonders". They were the first to admit that "jungle lore" may lead to medical triumphs.

Herbal Medicine in Sri Lanka

The medical wonders performed by King Buddhadasa with herbs that are documented in Mahawansa and Dipawansa provided us strong evidence for the existence of herbal medical practice in ancient Sri Lanka.

In our country we have two main systems of medicines. They are the traditional or indigenous system and the western or the allopathic system. According to a survey done by World Health Organization (WHO), about 80% of the total population in Sri Lanka depends on the traditional system of medicine for their basic health care. The traditional system of medicine in Sri Lanka can be divided into four different categories, namely Ayurveda, Deshiya chikitsa, Sidda and Unani. The Plant and herbal preparations are mainly used in Ayurveda and Deshiya chikitsa. In Ayurveda over 2000 medicinal plants are used while Deshiya chikitsa the number is about 500.

There are several limitations to the use of drugs in the traditional system of medicine in Sri Lanka. One is the problem of nomenclature, especially the confusion in the local names. There are five *Sida* species in Sri Lanka and they are all sold as Bavila. Similarly, *Adathoda* (*A.vesica*) is sold as Pavetta (*P.indica*) by Ayurvedic drug dealers. To check this, a pharmacogenetic investigation of the sample sold as Pavetta was undertaken. The major alkaloid was found to be vasicine, which is present in taxonomically identified sample of *Adathoda vesica*. The major alkaloid of taxonomically identified *Pavetta indica* was found to be different from vasicine.

The main limitation of drugs in the traditional system is the lack of standardization of raw materials, of processing methods and of the final products and non-existence of quality control criteria. If these limitations could be overcome not only would the majority of Sri Lankans accept these traditional systems of medicine but there will also be a demand for our traditional drug preparations in western countries, which would help to improve our ailing economy.

The Chemistry of Natural Products

A large number of organic compounds are found in nature, particularly in the plant and animal world. Since these compounds were not produced synthetically, substances obtained from natural resources become known as Natural products.

These naturally occurring compounds have found application in modern society. The most widely used of all natural products is ethanol. The stimulant most widely used in modern society is an alkaloid called caffeine, which is extracted by hot water from tea leaves or ground coffee beans.

In this programme our main attention will be focused on the plant metabolites. These metabolites can be divided into two major groups.

- 1) Primary metabolites
- 2) Secondary metabolites

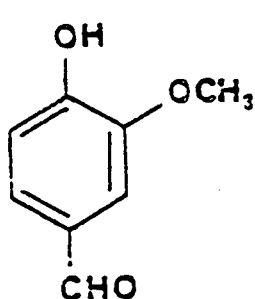
Primary metabolites are common to most of the living things. Generally they are macro molecules (e.g. carbohydrates, proteins and lipids).

The secondary metabolites are relatively small in size and their molecular weights are lower. Some of these secondary metabolites have biological activities such as,

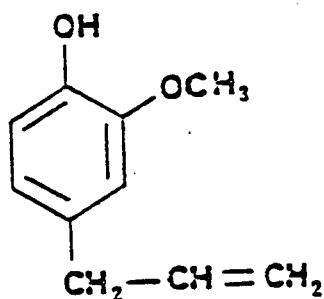
antibiotic
antiviral
anticancer
antitumour
antimalarial
antileukemic
anti-inflammatory
insecticidal

These secondary metabolites can be used in classification of plants in chemotaxonomy. Sometimes we find that given compounds are specific for one family or species or it may be a feature of a given genera. These compounds are called chemotaxonomic markers. We can use these markers to show similarities in plant families or species. These secondary plant metabolites may be

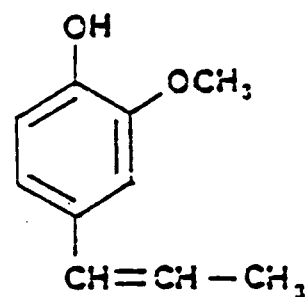
1) Phenolic Compounds



Vanillin
(Vanilla bean)



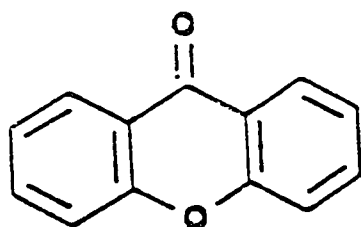
Eugenol
(Oil of cloves)



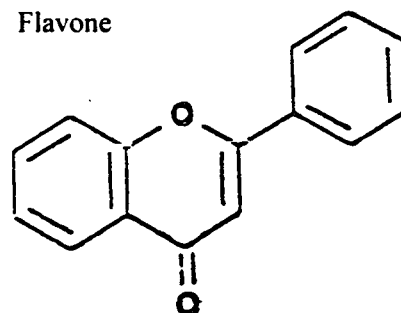
Isoeugenol
(Oil of nutmeg)

2) Oxygen-heterocyclic Compounds

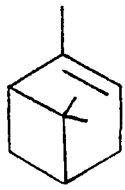
Xanthone



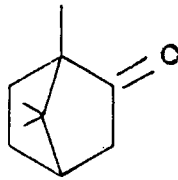
Flavone



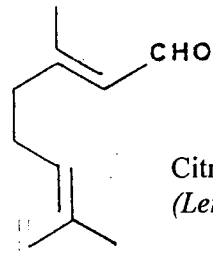
3) Terpenoids



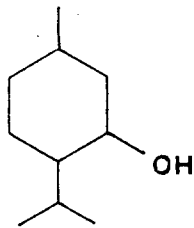
α -Pinene (*Pine tree*)



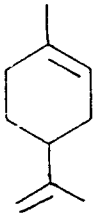
Camphor
(*Camphor tree*)



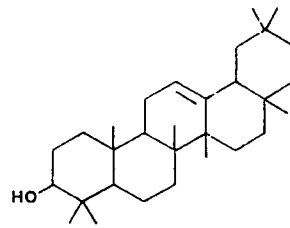
Citral
(*Lemon grass oil*)



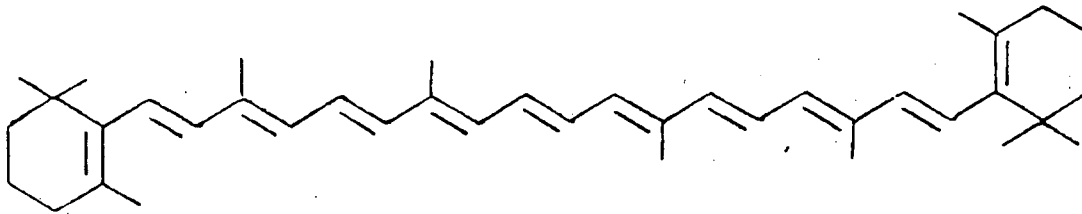
Menthol
(*Peppermint*)



Limonene
(*Citrus*)

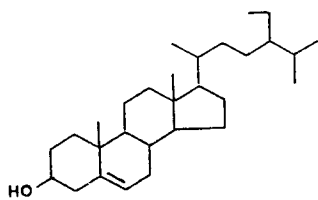


β -Amyrin

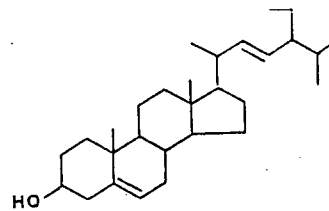


β -Carotene (*Carrots*)

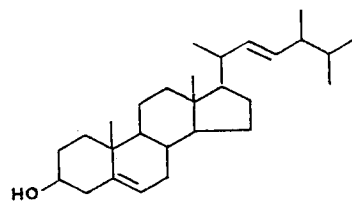
4) Steroids



Sitosterol

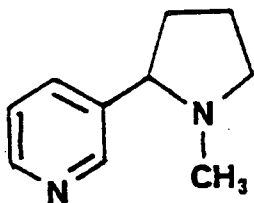


Stigmasterol
(*Soya bean oil*)

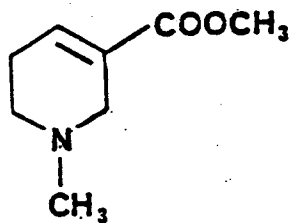


Ergosterol
(*Yeast*)

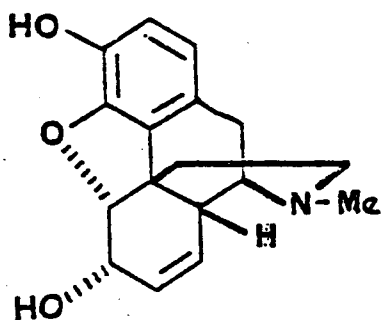
5) Alkaloids



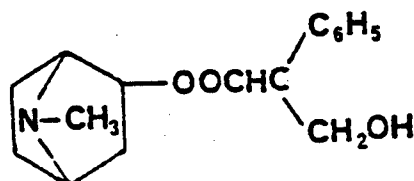
Nicotine
(Tobacco plant)



Arecoline
(Arecanut)

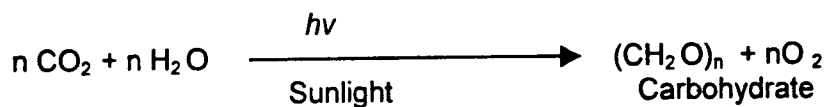


Morphine
(Opium)



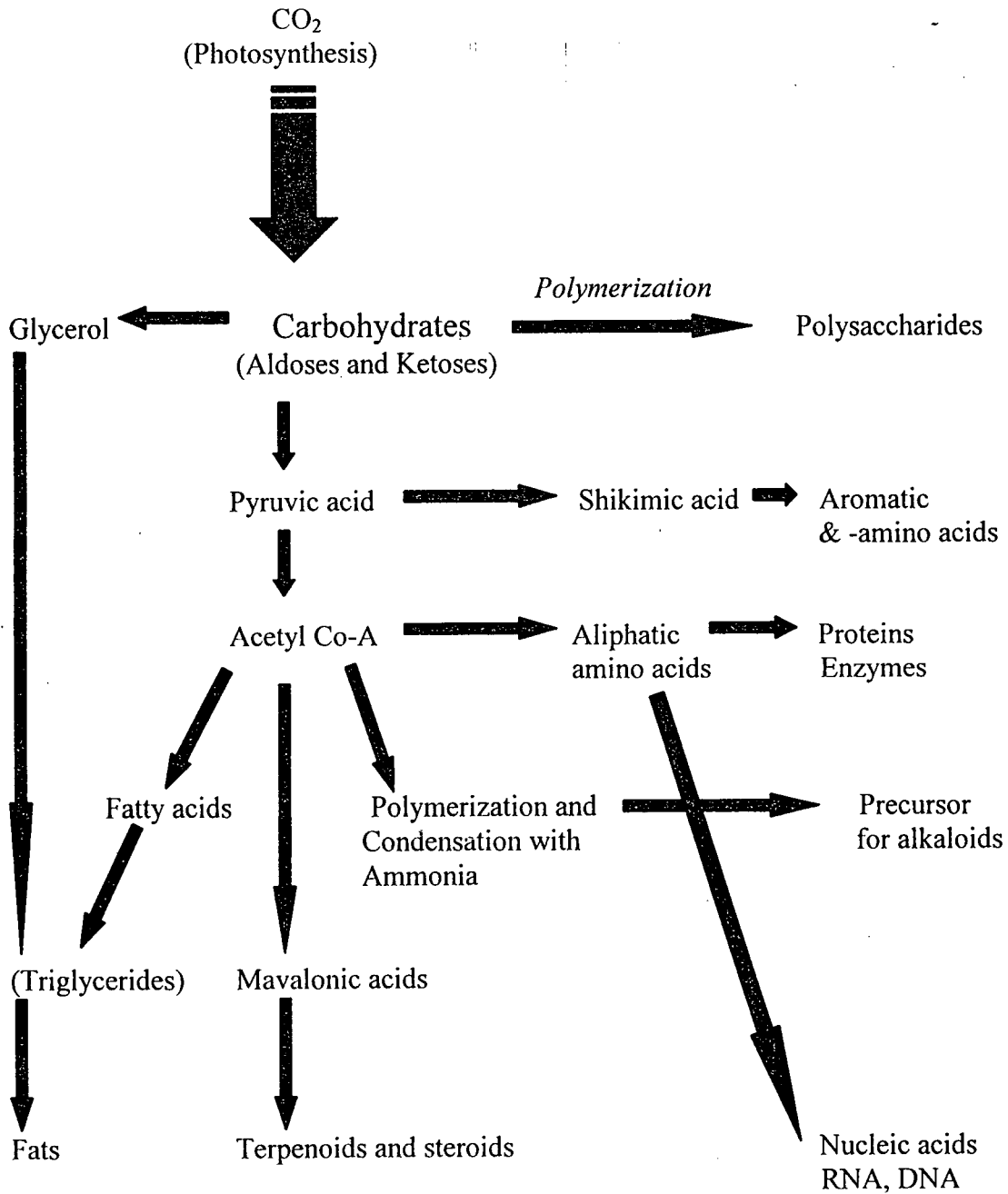
Atropine
(*Atropa belladonna*)

Plants are capable of making complex molecules from small molecules or atoms. Chlorophyll or modified chlorophyll containing plants are capable of making carbohydrates by CO₂ fixation. This process is called photosynthesis.

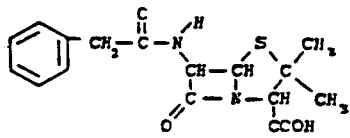
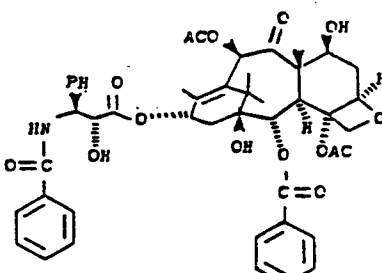
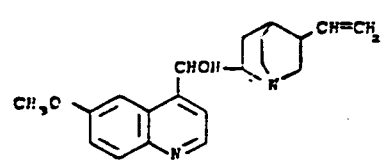
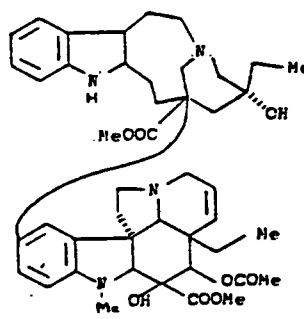
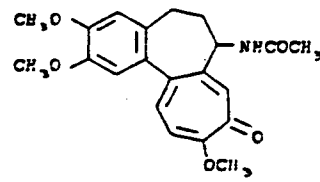


These photosynthesised carbohydrates contain aldoses and ketoses. They can undergo polymerization to give polysaccharides such as cellulose. Plant cell walls are mainly made of polysaccharides and they are primary metabolites. For each of these processes, plants need specific enzymes. Carbohydrates can undergo small changes and can give glycerol.

BIOSYNTHETIC PATHWAYS OF NATURAL PRODUCTS IN PLANTS



SOME BIOLOGICALLY ACTIVE NATURAL PRODUCTS

ACTIVITY	SOURCE	COMPOUND
Antibiotic	<i>Penicillium notatum</i>	 <p style="text-align: center;">Penicillin</p>
Anticancer	<i>Taxus brevifolia</i>	 <p style="text-align: center;">Taxol</p>
Antimalarial	<i>Cinchona species</i>	 <p style="text-align: center;">Quinine</p>
Antileukaemic	<i>Catharanthus roseus</i>	 <p style="text-align: center;">Vincalukoblastine</p>
Anti-inflammatory	<i>Colchicine autumnale</i>	 <p style="text-align: center;">Colchicine</p>