INTRODUCTION

Throughout the ages, Nature has provided humans with the means to cater for their basic needs. Plants are perhaps one of the interesting and mysterious things of the universe. Plants, since time immemorial, have continued to play an essential role in health care of many cultures throughout the known civilization as a valuable, safe and natural source of medicines and therapeutic, environmental and industrial applicability. Plants play a pivotal role in the existence of mankind. They are the elixir of life. World Health Organization (WHO) has estimated that approximately 65% of the world’s population relies mainly on plant derived traditional medicine for their primary health care. Our country has a very rich plant kingdom. Naturally the Indian system of medicine Ayurveda makes use of the plant kingdom very effectively and has stood the test of time. With the modern analytical facilities it is possible to study the plant ingredients in depth. Consequently many active principles in plants have been isolated, identified and put to use in varying fields like medicine and agriculture. Plant derived compounds can act as excellent lead to useful and more effective compounds.

Records dating from around 2600 BCE document the uses of approximately 1000 plant derived substances in Mesopotamia. These included oils of Cedrus species (cedar) and Cupressus sempervirens (Cypress) Glycyrriza glabra (Licorice) Commiphora species (Myrrh) Papaver somniferum (poppy juice) all of which continue to be used today for the treatment of ailments ranging from coughs and colds to parasitic infections and inflammation [1]. The documentation of Indian Ayurvedic system dates from before 1000 BCE (Charaka, Sushrutha and Samhitas with 341 and 516 drugs) [2, 3].
New information generated every day in the field of plant chemistry underscores the significance of phytochemical studies. The last few decades have witnessed tremendous advancement in natural products research. Natural products are ubiquitous in our day to day life. The therapeutic properties of these plants, disclosed by diverse cultures over the millennia, formed the basis of health care the world over. In early part of the 19th century, one of the challenges was to study these active principles. Phytochemistry and traditional medicine are inextricably linked; indeed it is curiosity that leads to the development of the other.

Many people are surprised to learn that about 25% of the pharmaceuticals prescribed by doctors in the developed world have their origins in the chemicals produced by flowering plants. Almost every culture within the wide diversity of the world’s population and habitats uses its local plants as medicines in some form or another. Some of the most ancient records detail the use of plants in this way in ancient Babylon, Egypt, India and China. Plant material was dried, crushed and extracted to give products that today would be called botanical medicines, herbal medicines, or phytotherapeuticals and the resurgence of interest and use of these forms of medicine in the developed world is one of the fascinating aspects of the last 20 years.

Phytochemistry is a branch of chemistry that deals with the study of plant secondary metabolites isolated from plant kingdom, their characterization, reactions, transformations and biological activities. This includes all aspect of chemistry from extraction and separations of plant constituents to structural elucidations using modern spectroscopic techniques. Phytochemical methods are applied in routine herbal medicine standardisations as well as modern drug discovery researches.
Recent advances in modern analytical methods such as NMR have now enabled us to isolate and characterise even minor constituents of purified natural products.

Two hundred years of modern chemistry and biology have described the role of primary metabolites in basic life functions such as cell division and growth, respiration, storage and reproduction. In biology, the concept of secondary metabolite can be attributed to Kossel [4]. He was the first to define these metabolites as opposed to primary ones. Thirty years later an important step forward was made by Czapek [5] who dedicated an entire volume of his ‘plant biochemistry’ series to what he named ‘endproduckt’. According to him, these products could well derive from nitrogen metabolism by what he called ‘secondary modifications’. Compared to the main molecules found in plants, these secondary metabolites were soon defined by their low abundance, often less than 1% of the total carbon, or a storage usually occurring in dedicated cells or organs. In the middle of the 20th century, improvement of analytical techniques such as chromatography allowed the recovery of more and more of these molecules, and this was the basis for the establishment of the discipline of phytochemistry.

Thanks to the improvement of biochemical techniques and the rise of molecular biology, it has been clearly demonstrated that secondary products play a major role in the adaptation of plants to their environment. These molecules largely contribute to plant fitness by interacting with the ecosystems. They have been described as being antibiotic, antifungal and antiviral, and therefore able to protect plants from pathogens (phytoalexins), and also anti-germinative or toxic for other plants (allelopathy).

Secondary metabolites, also referred to as natural products, are the products of metabolism not essential for normal growth, development or reproduction of an
organism. These compounds serve to meet the secondary requirements of the producing organisms. They empower them to survive interspecies competition, provide defensive mechanisms and facilitate reproductive processes. Well known sources of secondary metabolites are plants, bacteria, fungi and marine organisms such as sponges, tunicates, corals and snails. Many secondary metabolites have proved invaluable as antibacterial or antifungal agents, anticancer drugs, cholesterol-lowering agents, immunosuppressants, antiparasitic agents, herbicides, diagnostics, and tools for research. Some of these have found to play a pivotal role in treatment or prevention of a multitude of biological disorders, many of which did not have any cure until these products were discovered. In addition to their known activities and employment in combating disease, secondary metabolites reveal surprising additional activities which may be possible solutions to other diseases, some of which lack effective solutions. Many antibiotics, bacterial pigments, plant terpenoids, are also found to have anti-HIV, antitumor, anti-ageing, antiprotozoal and antihelminth activities, thus exhibiting multifarious applications in the sphere of medicine. Unraveling the novel applications of known secondary metabolites and exploiting a myriad of sources as microbes, plants and higher animals for screening new secondary metabolites are paving the way to treat “untreatable diseases”, and help reduce mortality rates.

Plant secondary compounds are usually classified according to their biosynthetic pathways [6]. Three large molecule families are generally considered: phenolics, terpenes and steroids, and alkaloids. A good example of a widespread metabolite family is given by phenolics: because these molecules are involved in lignin synthesis, they are common to all higher plants. However, other compounds such as alkaloids are sparsely distributed in the plant kingdom and are much more
specific to defined plant genus and species. This narrower distribution of secondary compounds constitutes the basis for chemotaxonomy and chemical ecology. Due to their large biological activities, plant secondary metabolites have been used for centuries in traditional medicine. Nowadays, they correspond to valuable compounds such as pharmaceutics, cosmetics, fine chemicals, or more recently nutraceuticals. Recent surveys have established that in western countries, where chemistry is the backbone of the pharmaceutical industry, 25% of the molecules used are of natural plant origin.

Natural product drugs have provided many challenges for synthetic chemists. There are several reasons why a naturally occurring drug may be synthesised, example some plant species have become threatened due to over collection from the wild, or the costs of collection, extraction and isolation may have proved too high for marketing. Also, synthetic analogues may be prepared in attempts to improve water solubility, pharmacological or safety profiles. For many years, natural molecules have acted as templates for the synthesis of new drugs and there are numerous examples of synthetic drugs that are based on the structure of a natural product molecule, example the analgesic pethidine was based on morphine and the antimalarial mefloquine on quinine.

New synthetic and semisynthetic analogues of natural products have continued to be developed during the past 50 years. Although Podophyllum species have reputations for treating cancers, Podophyllotoxin (1). Other anticancer drugs include Vinblastine (2) and Taxol (3) which are obtained as a minor component from the bark of mature trees of Taxus brevifolia and if sourced as such for anticancer chemotherapy, would result in massive loss of the species. Camptothecin (4) co-occurs with other alkaloids including 10-hydroxycamptothecin which proved
to be more active in anticancer test systems. Further modifications to the molecule were made to improve water solubility and lower toxicity resulting in two new clinical drugs. The antimalarial drug Artemisinin (5) is a hydrophobic and unusual sesquiterpene endoperoxide that has been isolated as the active principle of the Chinese antimalarial herb *Artemisia annua*. It is an antimalarial and used to treat infections of multidrug resistant strains of *Plasmodium falciparum*, the cause of human malignant cerebral malaria. Some anticancer drugs are given in Figure 1.

![Figure 1. Anticancer drugs from different plants](image1)

1. Podophyllotoxin
2. Vinblastine

3. Taxol

4. Camptothecin

5. Artemisinin
References:


