

# PHARMACOGNOSTIC STUDY OF SOME MEDICINAL PLANTS FROM GOA

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APPLIED BIOLOGY

BY

**RUDRAJI VISHVANATH GAITONDE**, *M. Pharm*  
GOA COLLEGE OF PHARMACY  
PANAJI - GOA

RESEARCH GUIDE

**Dr. ARVIND G. UNTAWALE**, *M.Sc., Ph.D.*  
SCIENTIST AND ASSISTANT DIRECTOR  
NATIONAL INSTITUTE OF OCEANOGRAPHY  
(Council of Scientific and Industrial Research)  
DONA PAULA, GOA - 403 004, (INDIA)



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C E R T I F I C A T E

As required under the University Ordinance 19.8(VI), I certify that the thesis entitled "Pharmacognostic study of some medicinal plants from Goa" submitted by Shri Rudraji V. Gaitonde for the award of degree of Doctor of Philosophy in Applied Biology is a record of research work done by the candidate during the period of study under my guidance and that it has not previously formed the basis for the award to the candidate of any Degree, Diploma, Associationship, Fellowship or other similar titles. I state that the experimental studies on phytochemical screening, microscopy, chromatography as well as a case study on Maesa indica, embodied in this thesis represent independent work on the part of the candidate.

A.G. Untawale

A.G. Untawale

(Research Guide)

Scientist and Asstt. Director

Biological Oceanographic Division

National Institute of Oceanography

(Council of Scientific and Industrial Research)

Dona Paula, Goa 403 004 (India)

## S T A T E M E N T

As required under the University Ordinance, I state that the work embodied in this thesis is based on the discovery of new relations of facts observed by the others and that the work tends to the general advancement of knowledge. The information regarding Pharmacological and Phytochemical aspects of these medicinal plants has been derived from the literature survey, the references for which have been cited in this thesis and also through regular drug sellers.

Except the works by Vartak (1966) and Rao (1986, 1987) no much information is available on these plants. The medicinal plants collected from Morlem forest of Sattari taluka, Goa have been reported for the first time. The microscopic work on these powdered crude drugs clearly indicated the diagnostic characters of these drugs. The technique utilised for the purpose is simple and workable. The thin layer chromatographic study employing silica gel G as adsorbent using eight developing solvents and some chromogenic spray reagents proved to be a good technique for the identification of the indigenous drugs based on the finger prints of the phenolic constituents. Two dimensional paper chromatographic study revealed a data on the distribution of flavonoids in these medicinal plants, the results of which helped as markers for the identification of the herbal products. These results can be computerised for the identification and characterisation of these crude drugs.

The Phytochemical survey of these plants indicated the presence or absence of the active constituents present therein, thus evaluating the plants for further study. The results compared with the previous work indicated the differences

between the plants from other localities.

Lastly, the case study on roots of Maesa indica gave a methodology for the extraction and separation of the active constituents, thus finding its way for the study of other plants specimens. The thesis thus represents original contribution to knowledge and advancement of existing knowledge in the field of pharmacognosy of medicinal plants.



*R.V. Gaitonde*  
R.V. Gaitonde  
(Ph.D. Candidate)  
Goa College of Pharmacy  
Panaji, Goa(India)

## CHAPTER I

### INTRODUCTION AND LITERATURES REVIEW

From earliest times, mankind has used plants in an attempt to cure diseases and relieve physical suffering. Primitive people in all ages have had some knowledge of medicinal plants derived as a result of trial and error. In all the early civilizations, there was much interest in drug plants. Biological studies have started as early as with the Greeks. The work of Aristotle (380 B.C.) on living and non-living things is well known. Theophrastus, a favourite pupil of Aristotle is well known (370 - 287 B.C.) for his botanical work. Pliny's work known as Natural History (23 - 79 A.D.) on medicinal plants was then reported. In China, as early as 5000 to 4000 B.C., many drugs were in use. There are Sanskrit writings in existence which tell of the methods of gathering and preparing drugs. The Assyrians, Babylonians and ancient Hebrews were all familiar with their use. Some of the Egyptian papyri written as early as 1600 B.C., record the news of many of the medicinal plants used today such as myrrh, cannabis, opium, aloes, hemlock and cassia. The Greeks were familiar with many of the present day drugs, as evidenced by the works of Aristotle, Hippocrates, Pythagoras and Theophrastus. King Assurbanipal of Assyria, living in the seventh century B.C. ordered that copies be made of Sumerian, Akkadian and Babylonian documents available to him. Among the 30,000 plates of cuneiform script unearthed from his library, a couple of hundred describe the use of drugs. Some of the original documents are known to have been written in about 4000 B.C. The oldest known herbal is Pen-tsao written by the Emperor Shen Nung (about 2700 B.C.) and contained 365 drugs. The famous medicinal papyrus

of Ebers written about 1700 B.C. described hundreds of drugs used by the ancient Egyptians. In 77 B.C., Dioscorides wrote his great treatise, "De Materia Medica", which dealt with the medicinal plants known at that time. Arabs made many advances in the field of medicinal plants. The Spanish-born Ibn al-Baitar described 1800 drugs of vegetable origin in the 13th Century. Li Shih-Chen, in China published in A.D. 1597 Pen-Ts'ao-Kang-Mu, a gigantic materia medica in 52 Volumes containing about 2000 drugs.

After the Dark Ages were over, there came the period of the herbalists and encyclopedists and the monasteries of Northern Europe produced vast compendiums of true and false information regarding plants, stressing in particular the medicinal value and folklore. Kao (1973) described the Chinese indigenous therapies and procedures for the advancement of new anti-inflammatory drugs, the bold theory of using purgative in appendicitis in conjunction with herbs and acupuncture, delicate limb and digital connection surgery, the employment of ancient Chinese herbs for the substitution of skin in treating burns and new experimental techniques and concepts that treat man as a whole entity. Alland (1970) described the widespread and long-standing practice of using plants in medicine in Eurasia, especially around the Mediterranean, the sub-continent and China. Stern (1974) explained the system of the Egyptians, the Babylonians and the Vedic Sanskrit. Following the contributions to medicine of Hippocrates (460 - 377 B.C.), Dioscorides (first century A.D.) and Galen (A.D. 31 - 200), together with the early Arabian physicians, there was essentially a period of 1000 years during which little, if any, progress was achieved either in the medicinal sciences or in botany. As far as the classification of plants was concerned, it was Cesalpino (1583) who classified plants according to their flowers and fruits. Bauhin (1596, 1623) described 6000 plants for the first time into definite genera. John Ray (1686 - 1688) categorised plants into dicot and monocot plants with further groupings as families. Linnaeus (1730, 1735, 1737, 1742, 1753) described the

plants in a sequence like class, order, genus and species and introduced the binomial system which is still followed.

Chopra (1958) has described the history of medicine in India from the remote past. The earliest mention of medicinal age of plants is to be found in Rigveda, which is one of the oldest repositories of human knowledge having been written between 4500 and 1600 B.C. In this work, mention has been made of the Soma plant and its effect on man. In the Atharvaveda, which is the later production, the use of drugs is more varied. It is in the Ayurveda which is considered as an Upaveda, that definite properties of drugs and their uses have been given in some detail. Ayurveda in fact is the very foundation stone of the ancient medical science of India. It has eight divisions which deals with different aspects of the science of life and the art of healing.

The age of Ayurveda is fixed by various Western scholars at somewhere about 2500 to 600 B.C. The eight divisions of Ayurveda were followed by two works written later i.e. Susruta and Charaka. About the date of Susruta, there is a great deal of uncertainty but it could not have been written later than 1000 B.C. In this work surgery is dealt with in detail but there is a comprehensive chapter on therapeutics. Charaka written about the same period, deals more with medicine and its seventh chapter is taken up entirely with purgatives and emetics. In the twelfth chapter, there is to be found a remarkable description of materia medica as it was known to the ancient Hindus. From this period down to the Mohammedan invasion of India, Hindu medicine flourished. Its progress may briefly be traced through four distinct stages, namely: (1) Vedic period, (2) Period of original research and classical authors, (3) Period of compilers and also of Tantras and Siddhas and (4) the period of decay and recompilation. During the second and third periods, the progress was remarkable in every respect and Ayurveda then attained its highest development. The nations of the civilised world of that time eagerly sought to obtain information regarding the healing

art from the Hindus of those times, the influence of Hindu medicine permeated far and wide into Egypt, Greece and Rome. The work of the great Physician, Dioscoroides definitely shows to what an extent the ancient were indebted to India and the East for their medicine. Many Indian plants are mentioned in his first work, particularly the aromatic group of drugs for which India has always been famed. The smoking of Datura in cases of asthma, the use of Nux vomica in paralysis and use of Croton as purgative can be definitely traced to have originated from India. Some old Sanskrit works dealing with the classification of vegetable drugs and the utilisation of their parts in medicine as practiced by the Hindu physicians of fourteenth or fifteenth centuries ago, provides a most interesting reading. In books like Kalpasthanum, elaborate classifications of drugs and medicinal plants are given. Divisions are made under such headings as roots, barks, leaves, flowers, fruits, seeds, acrid and stringent vegetables, milky plants, those containing gums and resins, etc. In the same work, the earliest references occur respecting botanical geography, the sites and climates of different plants, the soils and seasons for collecting medicinal plants, the duration of their efficiency, the method of storage and the weights and measures to be used in pharmacy. There is evidence to show that even in the early Buddhistic period, pharmaceutical gardens were established for growing drugs and herbs for supply to the physician. Detailed instructions are given on every point such as a gathering time, parts to be collected, making of preparations from them, etc.

The study of Indian indigenous drugs was first begun in the early part of the last century and it was then confined to the collection of available information about various medicinal plants. The earliest contribution was in 1810 by John Fleming's "Catalogue of Indian Medicinal Plants & Drugs, Ainslies' Materia Medica of Hindoostan, in 1813 and Roxburg's Flora Indica in 1824. This was followed in 1841 by O'Shanlinessy's "The Bengal Dispensatory and Pharmacopoeia"

which was the first book of its kind which dealt with properties and uses of medicinal plants used in Bengal. In 1868 a Pharmacopoeia of India was published under the able editorship of Waring and it signalled a new epoch in establishing and recording the value of indigenous medicinal products. The most elaborate work of all is "A Dictionary of the Economic Products of India" published in 1889 - 1893 by Sir George Watt - the Reporter on the Economic products to the Government of India. This monumental work not only gives a summary of all the previous works on the medicinal plants but every page of it teems with information regarding the use of different barks, roots, flowers, leaves and woods for different medicinal purposes. Work published still later such as Kanny Lal Dey's Indigenous Drugs of India (1896) and Kirtikar & Basu's Indian Medicinal Plants (1935) are largely summaries and compilations from the above mentioned literature.

Apart from the present volume, another recent work on the subject is "The Wealth of India" 1949 - 53, a very comprehensive treatise which is being published under the auspices of the Council of Scientific and Industrial Research New Delhi.

There are a number of drugs used by the medical profession but which do not naturally grow in this country; they thrive when they are cultivated in our country. Examples: Digitalis, Ipecac, Cinchona, etc. India possesses most wonderful variability so far as the temperature and general climatic conditions are concerned and every drug ranging from those growing in the hottest tropical and damp climates to those growing in dry, temperate and very cold climates can be grown and acclimatised in some part or the other.

During three decades that have followed, the research work on indigenous drugs has received considerable encouragement and has made satisfactory progress. Such semi-Government organisations as the Indian Council of Medical

Research, the Indian Council of Agricultural Research and the last but not the least, the Council of Scientific and Industrial Research, have given very generous grants to various medical institutions and other research bodies for this work. In fact, the last named, the Council of Scientific and Industrial Research established in 1950, the Central Drug Research Institute at Lucknow, is one of the eleven major national laboratories in India. One whole division of this Great Institution is devoted entirely to the study of Indian indigenous plants.

Plants have been studied in India from times immemorial, particularly with reference to their medicinal properties. The Botany of Vrikshyurveda as it was called in ancient India, was a part of the curriculum in seats of learning, comprising collection and study in relation to environment and their efficacy as a medicine and classification was based on such studies. Sanskrit nomenclature has been quite clear and consistent which was adopted by Heinrich van Rheede (1678 - 1703) in his book, "Hortus Malabaricus" which is in fact the main source of inspiration for Linneaus (1753) in naming Indian plants in his "Species Plantarum". Goa region which is rich in Indian culture and study of Ayurveda, would have been another center for the preparation of useful floristic treatise similar to Hortus Malabaricus with the cooperation of Konkani scholars and Ayurvedic Vaidyas, had the Portuguese administrators who governed the region since 1510, expressed their interest on such projects.

Goa is a small coastal district, roughly in the middle of the Western sea face of the Peninsular India. It forms a part of Southern Konkani with several ingressing arms of Arabian Sea, especially at the confluence of many fast moving short rivers and streams arising in the Western Ghats, e.g. Zuari, Mandovi, Talpona, etc. It is located between  $14^{\circ} 53' 54'' - 15^{\circ} 48' 00''$  N. and  $73^{\circ} 40' 33'' - 74^{\circ} 20' 13''$  E. with an area of about 3701 sq.kilometres. The average rainfall is about 110 inches. The mountain ranges running across the main lines of the

Western Ghats or the Sahyadris provide many shady pockets for luxuriant growth of rich vegetation of the semi-evergreen or evergreen types and they form a green belt throughout Goa. Its territorial individuality is entirely related to its political past as a Portuguese Colony from 1488 A.D. to its merger with the rest of India in 1961. For the last 450 years, Goa despite its rich vegetation and scenic beauty, was cut off from the influence of the main land due to alien rule. At the same time, Portuguese explorers brought many plants from their possessions in other parts of the world, the Far East, Africa, Mozambique, South America, etc. and tried to grow them in Goa. Goa therefore is not only rich in indigenous plants but also in exotics.

Garcia da Orta (1563), the personal physician to the Viceroy of the Portuguese Colonies in India, with his vast experience of 30 years contact with the local Ayurvedic Vaidyas and the use of Indian medicine, published Coloquios dos Simples e drogas he cousas medicinais da India, e assi dalguas frutas achadas nella tocantes a medicina, pratica e outras cousas boas pera Saber copostog, an interesting pre-Linnean publication, presenting a detailed account of fifty-seven more commonly used Indian medicinal plants from Goa. This became known to Europe mainly from its Latin translation by Clusius (1567), "Aromatum et Simplicium a Liqnot Medicamentorum apud Indos Nascentium Historia". This Latin translation became so popular that it ran into six editions between 1567 and 1595. Conde de Ficalho (1886) an accomplished botanist published a standard annotated edition of this Coloquios with full and admirable notes with botanical names to each colloquy, evidently after consulting all books and research papers. To English readers, Sir Clements Markham's translation (1913) of Ficalho's edition at London was a welcome edition but Soares (1923) in his Article as "Garcia d'Orta, a little known owner of Bombay" indicated that Markham's translation was full of errors. However, 250 copies of this translation were printed and the Copy No.178 is available in Blatter Herbarium of St.Xavier's College, Bombay.

The Spanish work of Acosta (1578) "Tratado das Drogas a Medicinas das Indias Orientaes" is another book appearing after Orta's colloquios. Though in the preface of this book, it is mentioned that it is the original work of Acosta, Markham indicated that out of 448 pages of text, giving 69 plants, the greater part of it was mostly copied from Orta. However, Acosta's drawings of the plants collected at Cochin and Goa, are found to be useful to illustrate the Colloquios. During the following decades it went through and was translated by the following botanists — Roxburg (1824) published, Flora Indica, occasionally referring to plants of this region as belonging to Konkan, Graham (1839) in his catalogue of Bombay plants has often referred to Lush, who had earlier collected plants from Goa forests. Dalzell & Gibson (1861), Nairne (1894) have also referred to plants from this region in their work. Hooker (1872-97) in his "Flora of British India" often quoted the earlier botanists in the context of plants occurring in Konkan and Goa in particular. Except for this, there is practically no record of any plant material or herbarium specimen from the Portuguese territories of India in the Indian publications on botany of that period. The only half-hearted attempt made by the Portuguese Government to study the natural history of Goa was to commission Manoel Galvao da Silva (1862) to prepare the work "Observacoes sobre e Historia Natural de Goa". This work consisted of 46 pages with 163 species of indigenous and exotic, covering more than half the book and the remaining pages with a brief outline of the Linnean System of classification. D.G. Dalgado says that D'Silva spent hardly two months in Goa and completed the work. D.G. Dalgado (1894) published "Classificac̃ao Botanica das Plantas e Drogas descritas nos Coloquios da India" in Bombay, classifying the plants described by Garcia D'Orta in his Colloquios, with their botanical names and fine drawings of the plants; but later, probably with the publication of Hooker's (1872) Flora of British India, the Portuguese authorities might have encouraged Dalgado (1898) to prepare his "Flora de Goa e Savantvadi", Lisbon to commemorate their rule of 400 years on Indian territory. Dalgado in his introduction to his Flora indicates that

he planned for seven years to complete his work and due to his stay for about 22 years as a Medical Officer in Savantwadi State, he included the States besides Vengurla and Malwan talukas along with Goa region. This publication of Dalgado, presented a list of 731 wild species under 478 genera classified into 134 families and 279 cultivated exotic species under 206 genera representing 69 families. The vernacular names in Konkani were adopted from Diccionario-Konkani-Portuguez by S.R. Dalgado (1893) and other local workers and the Portuguese names from "Compendio de Botanica" by Felix Avellar Brotero and also Coloquios by Garcia d'Orta. English and French names were from Indian and other various works. Thus his book as compared with others then published in British India, turned out to be only an improved list of plants with brief notes.

In the later period, several botanists of the then Science College, Pune, under the leadership of Theodore Cooke had made extensive plant collections in various parts of the then Bombay Presidency. It appears from records that these botanical visits were often extended to adjacent parts of Goa. This collection was kept in the Herbarium of the Economic Botanists Agricultural College, Pune. It is now kept in the Botanical Survey of India, Western Circle, Pune. "The Flora of Presidency of Bombay" by Cooke (1901 - 1908) and "Forest Flora of the Bombay Presidency" by Talbot (1909 - 1911) are the records of some of the medicinal plants from Goa.

Botanists at the St. Xavier's College, Bombay also made substantial contributions by collecting and reporting plants from Goa. Blatter and De Almeida (1922) reported 42 species of ferns. Blatter and McCann (1935) reported over 50 species of grasses. Souza (1944) published a paper entitled "Catalago Botanico das Plantas de Goa e Terras Vizinhas"

With such advancement of botanical knowledge in Western India, some

workers from Goa also published papers, a few of which are noted here:-

Gracias (1896, 1899, 1902, 1912) published Memoria Sobre Pogosteman Parviflorus os legumes e os Cercaes de Goa e Damao, Suas Propriedads, Usos economicos e terapeuticos e analyse Chimica; Flora Economica e Industrial da Provincia de Pragana Nagarhaveli (India Portuguesa) Memorias da Academia Real das Sciencias and Flora sagrada da India o Mythologia das Plantas Indianas, Com Sua classificacao, nomenclatura, descricao, Propriedades e usos medicinaes economicos e industrial e composicao Chimica, respectively. Alfonso (1924, 1940) published O Coqueiro and A contribuicao Portuguesa Para o desenvolvimento does recursos naturais da India e do Oriente respectively. Barreto (1954 a, b) published Plantas de Goa empregodas na culinava e Outros usos domesticos and plantas aromaticas de Goa com possibilidade de serem utilizadas na Industria de Perfumes, Loços, Pomades aleos medicinaes. Barreto (1956, 1957, 1958) published many papers related to Plantas medicinaes de Goa. Noronha & Pinto (1954) published Estudo de Principios Activos de Gymnema Sylvestre, Vaidia (1954, 1955) published papers Estudo sobre e Historia da Farmacia Ayurvedica. V.D. Vartak(1966) prepared a list of 1512 species covering the region from southern parts of Ratnagiri District to Northern part of North-Kanara District under an old regional name 'Gomantak' ("Enumeration of Plants from Gomantak", India 1966).

Subsequently with the reorganisation of the Botanical Survey of India and setting up of the Western Circle of the Department in December 1955, a new line of activity in the exploration of various unexplored as well as under-explored regions along the Western parts of India has begun. Rao (1985, 1986) took comprehensive study of Flora of Goa, Daman, Diu, Dadra & Nagarhaveli as a part-time project in the end of 1962 and published "Flora of Goa, Daman, Diu, Dadra and Nagaraveli".

What lends the district of Goa its scenic charm must be principally attributed to its vegetal cover consisting of three main categories; the typical

tropical monsoonal forests of the Sahyadrian Ghats and their extensions along the projecting hill ranges towards the coastlands, the poor cover of grass and scrub on its lateritic plateaus and the fringing belts of vegetation along the estuaries and shoreline.

The tropical wet evergreen forests occur in strands in the deeper valleys of the Ghats. This is a rich vegetation of evergreen type with a variety of species. They have an area of 250 sq. kilometers but are dispersed in patches. Tall trees, dense canopy, sparse middle layer, climbing creepers and dense humus matting are characteristic. The tropical moist deciduous forests occupy a large area of the Sahyadrian Goa. High tree species with close canopies are common. Many evergreen types occupy the lower layer and the undergrowth has bamboo and cane in many places. Laterite thorn forest is the third main type occurring in Goa. The hard, dry and shallow soils of the lateritic plateaus mainly the result of indiscriminate destruction of the earlier cover support only scrub of 'Acacia gundra' type with coarse grasses occupying the major areas; in places these are laced with fringes of Karwand ("Carissa carandas") thickets.

The mangrove forests are extensive in the estuaries of the Mandovi and Zuari rivers, particularly in the silted up fringes of the Cumbarjua canal; they are also to be found in the minor estuaries towards north and south. Above the tidal limits, wherever the relief allows formation of beaches, typical beach flora tends to occur with shrubs and maritime grasses.

### Climatology

The average annual rainfall which is continuous from June to October is 2500 mm. The monsoon bursts over the territory in the beginning of June &

withdraws from it by early October. As a result of the orographic influence, rainfall increases rapidly towards the western ghats from 2500 - 3300 mm along the coast to over 4000 mm nearer the ghats. Over 90 percent of the annual rainfall occurs during the monsoon months of June to September. July is the rainiest month when about 36 percent of the annual rainfall is recorded.

This territory gets rainfall of 10 mm or more on 70 to 100 days in a year on an average, the number of rainy days (i.e. days with rainfall 2.5 mm or more) being 100 to 125. As in the case of rainfall, the average number of rainy days is more in the eastern portion of the Territory, nearer the ghats, than near the coast. Occasionally, rainfall over the territory becomes heavy and vigorous in association with cyclonic disturbances which form in the Arabian Sea or those which form in the Bay of Bengal and emerge into the Arabian Sea, after crossing the Peninsula. Due to the maritime influence the diurnal range of temperature during the day is not large. The diurnal range is the least, being 4-6°C during the monsoon season and increased to the maximum of 10-12°C during December to February. Temperature variation through the seasons are also slight. May is relatively the warmest month when the mean daily temperature at a slightly lower value of about 25°C. It is interesting to note that the day temperatures are lowest in the monsoon months of July and August and not in the 'cool weather' months of December and January. Maximum temperatures are at their highest (around 33°C in the mean) in the pre-monsoon months of April and May and again in the post-monsoon months of November and December. On the other hand, lowest night temperatures of the order of 20°C are experienced in December and January. During the winter season, cold and dry continental air from the North is prevented by the Western Ghats from exerting its full influence over the territory with the result that temperatures do not fall appreciably in the same way as they do inland to the east of the ghats or even along the coast in the north. Along the coast, the maximum temperature rarely goes beyond 37°C. Due to the proximity of the sea, the territory is generally humid, with a further rise in humidity during the monsoon period. Even during the

summer months the relative humidity is generally above 60 percent.

Skies are clear to lightly clouded from November to March, with gradual increases thereafter till May after which there is a sharp increase in cloudiness with the onset and advance of the monsoon; skies remain mostly clouded to overcast till September. Cloudiness decreases sharply after October. Winds in the morning are easterly to north-easterly during October to April backing to north-east in May, while in the afternoon they tend towards west or north-west, due to the sea breeze effect. During the monsoon months the winds are generally westerly throughout the day. Winds are fairly strong during the monsoon period. Otherwise they are generally moderate in strength.

#### Geomorphology, geology & geo-chemistry

The physiography of the Goa District chiefly comprises of undulating terrain of western Ghats in a series of hills with several off-shoots and spurs gradually merging in the West. In the East bordering Karnataka State, the hill ranges are precipitous upto an elevation of 1022.50 metres. The Western Ghat is the source of two prominent rivers in Goa, viz: Mandovi and Zuari that flow off into the Arabian Sea near Panaji and Vasco-da-Gama.

#### Vegetation:

The vegetation can be broadly classified into following types:

(1) Coastal Vegetation: (i) Estuarine vegetation consisting of mangrove species along the narrow muddy banks of rivers; (ii) Strand vegetation along the few coastal belts; (iii) Plateau vegetation comprising of low deciduous as well as moist deciduous species confined especially to the lower elevations of the ghats; (iv) Semi-evergreen and evergreen forests limited to patches along the

upper elevation of the Ghats. Altitudinally, the estuarine and strand vegetation range from sea level to 50 m., the low deciduous and moist deciduous species fall within 50 - 500 m. and the semi-evergreen and evergreen forests occur from about 500 m. upwards. Besides, the area abounds in many hydrophytes and grass lands which occur at all elevations. The composition of the various types of vegetation has been briefly analysed below: -

(1) Coastal Vegetation : Sea-weeds, sea-grasses

(i) Estuarine vegetation of mangrove along swampy river banks

Botanically this zone is characterised by the presence of halophytes with their peculiar root formations (stilt roots of Rhizophora spp., Pneumatophores in Avicennia spp., knee roots in Bruguiera spp. etc.) and Viviparous fruits for seed disposal in all genera. Thickets of species of 'Rhizophora', Bruguiera, Kandelia, Lumnitzera, Sonneratia and Avicennia readily strike the eye. Often 'Acanthus ilicifolius' represents pure formations and near the high tide mark.

(ii) Strand and Creek vegetation along coastal belt

The vegetation along the south bank of River Mandovi near Panaji comprises tree species such as Karanji (Pongamia glabra), Bhendi (Thespesia populnea), Undi (Calophyllum inophyllum) and Keura (Pandanus odoratissimum) some of which are exotics but naturalised, growing wild, whereas Mad (Cocos nucifera) and Saro (Casuarina equisetifolia) are extensively cultivated in Goa. Along the rocky creeks and projecting ridges facing the coast, could be seen many herbaceous species of Neanotis, Iphigenis, Scilla, Cyperus, Naregamia and Begonia.

(iii) Plateau vegetation along undulating terrain and foot hills:

A major portion of Goa belongs to this category with the

scrub jungles extending from 50 - 200 m. and the deciduous forests confined to 200 - 500 m. altitude.

- (a) Open scrub jungle - Undulating rocky plateaus with scant vegetation are met with along Panaji to Cortalim, Panaji to Colvale, Cortalim to Margao and from Bicholim to Sanquelim, to mention a few, which are due to manganese ore mining, "Kumeri" cultivation, overgrazing and other biotic factors. Kaju (Anacardium occidentale) is cultivated on an extensive scale. Severely eroded wastelands sustain patchy vegetation composed of dry deciduous species such as Karvandi (Carissa caranda), Kindo (Holarrhena antidysenterica), Ghaneri (Lantana camara), Dhaxri (Woodfordia floribunda), Ansali (Grewia microcos), Nigad (Vitex negundo) etc. The majority of climbers are confined to families like Menispermaceae, Vitaceae, Asclepiadaceae and Liliaceae.
- (b) Moist deciduous forests - Forests around Tudal, Ordofond, Butpal, Molem, Codal, Ambiche Gol near Valpoi and Anmode Ghat are essentially moist deciduous and much of the forest area in Goa falls under the above type. The important components of the deciduous forests belong to species of Rubiaceae, Bignoniaceae, Anacardiaceae, Sapindaceae, Fabaceae, Caesalpiniaceae and Mimosaceae. The ground flora in forest clearings and exposed situations comprise members of Fabaceae, Acanthaceae, Rubiaceae, Euphorbiaceae, Asteraceae, Lamiaceae. Also fern species such as Pteris aquilina, Salaginella imbricata and Ophioglossum nudicaule are seen on the moist forest floor.

Moist Deciduous Forests (Commercially Potential)

Along the foot-hill slopes of hill tract traversing from North to South and spurs leading towards West, in the talukas of Ponda, Canacona, Quepem, Sanguem and Satari, there are commercially potential forests categorized as "B" class for exploitation of the forest produce by the State to earn maximum profits and for regeneration of the crop on perpetual basis. This type of forest is distributed in about 385 sq. kms., providing the timber and fuel wood requirements of the district. Natural teak is of sporadic occurrence in these forests, yet the tract has rich potential for bearing teak. The prominent tree species in this zone are Asan (Terminalia orenulata), Arjuna (Terminalia arjuna), Kindal (Terminalia paniculata), Zambo (Xylia xylocarpa), Nano (Lagerstroemia lanceolata), Ghoting (Terminalia bellerica), Siso (Dalbergia latifolia), Edu (Adina cordifolia), Kadam (Mitragyna parvifolia), Karmal (Dillenia pentagyna), Tambdo Assan (Pterocarpus marsupium) and Kosimb (Schleichera oleosa).

In the understorey, common tree species found are Dhaman (Grewia tiliafolia), Shiras (Albizzia lebbec), Kinnai (Albizzia procera), Phatarphod (Bridelia retusa), Shivan (Gmelina arborea), Moi (Lannea coromandelica), Bel (Aegle marmelos), Kastel (Hydnocarpus wightiana), Sendri (Mallotus philippensis), Charoli (Buchanania latifolia), Kalo Kudo (Wrightia tinctoria) and Kumbyo (Careya arborea).

The ground vegetation consists mostly of Gelphal (Randia dumetorum), Alataya (Helioteres isora), Karvi (Strobilanthes callosus), Dimdo (Lea sambucina), Menki (Glycosmis pentaphylla), Dikna (Ardisia solanacea), Ranbhendi (Urena lobata), Karvandi (Carissa carandas), Damdarlo (Flemingia congesta), Saykilo (Clerodendron infortunatum), Kudo (Holorrhena antihysenterica), Karbel (Murraya koenigii), Adki (Rauvolfia serpentina), and Vadli namdit (Tabernaemontans coronaria). The common climbers of these forests are Ukshi (Calycopteris floribunda), Kante-bhonvri

(Ichnocarpus frutescens), Ghotivel (Smilax zeylanica), Chilhar (Caesalpinia sepi<sup>a</sup>ria), Vagati (Wagatea spicata), Wakeri (Caesalpinia nuga) and Churan (Zizyphus rugosa).

(iv) Semi-evergreen vegetation: The tallest trees are composed of species of Ud Champo (Michelia champaca), Gulmara (Cryptocarya wightiana), Disa (Actinodaphne hookeni), Wad (Ficus bengalensis), Narain (Lagerstroemia lanceolata), Kanak Champo (Pterospermum acerifolium) mixed with smaller tree species such as Bhoma (Glochidion hohenackeri), Dhavi Pitkoli (Ixora parviflora), Bok (Bischofia javanica), Chandivado (Macaranga peltata) and Londa (Hopea racemosa).

Evergreen forests: The evergreen forests never reach the climax in Goa region as they do in North Kanara district of Karnataka and the Amboli-Ramghat belt of the South Ratnagiri. The transition from the semi-evergreen forests to the evergreen is gradual and almost imperceptible. The tree components are selected and few limited to such families as Clusiaceae, Ebenaceae, Lauraceae, Moraceae, Euphorbiaceae and Burseraceae. The lofty trees belong to species of Calophyllum, Garcinia, Canarium, Lophopetalum, Chrysophyllum, Artocarpus and Diospyros whereas the medium sized tree species are composed of Litsen, Ficus, Aporosa, Antidesma, Carallia, Evodia and Mallotus.

As compared to the evergreen forests of North Kanara, the epiphytes are comparatively poor, limited mostly to members of Orchidaceae, Asclepiadaceae and Araceae. A few species of Utricularia, Habenaria and Begonia are seen in the crevices of tree bark wherever there is a little soil and moisture, thus superficially appearing as epiphytes. The root parasites belong to members of Scrophulariaceae, Santalaceae and Orobanchaceae. The stem parasites are predominantly composed of members of Loranthaceae. The terrestrial orchids include species of Platanthera, Malaxis together with species of Habenaria and Peristylus.

### Evergreen and semi-evergreen forests

Along the north-eastern and south-eastern portions bordering Karnataka State, few evergreen and semi-evergreen vegetation occurs in the deep gorges and ravines of Sanguem, Satari and Canacona talukas. On the precipitous aspect the tree growth is mostly stunted having low timber value. In this zone of forests the annual rainfall varies from 5,100 millimetres to 7,600 millimetres. The trees of common occurrence are Bobbi (Calophyllum wightianum), Jambul (Eugenia jambolana), Ambo (Mangifera indica), Onval (Mimusops elengi), Otamb (Artocarpus lakoocha), Ranpanas (Artocarpus hirusta), Nag Champa (Mesua ferrea), Kavsi (Hopea wightiana), Bhirand (Garcinia indica), Olam (Maohilus macrantha), Dalchini (Cinnamomum zeylanicum), Chandivado (Macaranga peltata), Kuhimdar (Steroulia guttata), Kalezad (Diospyros embryopteris), Bibo (Semecarpus anacardium), Ranbibo (Holigarna amottiana), Bhoma (Glochidion hohenaekeri), Peddhaliki (Olea dioica), Tusal (Heynea trijuga) and Arola (Mallotus philippinensis). The undergrowth is comprised of Dosari (Colebrookea oppositifolia), Thinpudi (Triumfetta rhomboidea), Ayamsar (Callicarpa ianata), Dhavi-pitkoli (Ixora barbata), Dhavru (Woodfordia fruticosa), Baknol (Lobelia nicotianaefolia) and Nakeri (Melastoma malabathricum). The common bamboos occurring in these forests are Man (Bambusa vulgaris) and Kanaki (Dendrocalamus strictus). Vet, Rotam (Calamus rotang) is the important cane of evergreen belt. Kombal (Gnetum scandens), Chilhar (Acacia intsia), Garyel (Entada pusaetha), Amrutvel (Tinospora cordifolia), Ajravel (Coculus macrocarpus), Padvel (Stephania hernandifolia), and Bhatvel (Cissampelos pareira) are the common climbers of these dense forests. In the ravines, the tree growth is luxuriant with clear boles attaining a height of 10 to 15 metres. Both evergreen and semi-evergreen forests are distributed over an area of 256 sq.kms. of which 50 percent of the area is inaccessible. The zone of evergreen forests has been classified as 'A' class forests under the Portuguese regulation of forests, set apart for preservation of climate, regulation of waterflow and conservation of soils in the hilly tracts.

TALUKA-WISE GEOGRAPHICAL AREA VIS-A-VIS FOREST AREA (UNDER GOVT. CONTROL)

		Geographical area in Ha.	Forest area in Ha.	Percentage forest area to geo-area
1		2	3	4
1) Tiswadi	...	16,612	...	...
2) Salcete	...	27,719	...	...
3) Bardez	...	26,480	...	...
4) Mormugao	...	7,831	...	...
5) Ponda	...	25,228	2,931	11.62
6) Bicholim	...	23,633	716	3.03
7) Pernem	...	24,200	1,319	5.45
8) Quepem	...	43,731	11,679	33.63
9) Sanguem	...	88,660	50,070	56.48
10) Canacona	...	34,736	14,328	41.25
11) Satari	...	51,284	24,252	47.29

Economic and Medicinal Plants - Species of Cocos, Anacardium, Mangifera, Ananas, Areca, Piper, Artocarpus, Musa, Citrus and Psidium and their cultivation and further development on commercial basis are quite well known. Species of Garcinia, Cinnamomum, Myristica, Murraya as condiments deserve a mention for their utility. A few other plants like species of Flacourtia, Averrhoa, Litchi, Phyllanthus are also grown for their edible fruits.

As for the timber, variety of woods are in demand with the developing industrialisation and some of the species suggested here are known for their quality of wood. With proper management of deciduous and semi-evergreen forests, most of the species can be brought into the approved range of species required for

wood-based industries. Besides the well-known timber species of Terminalia, Tectona, Lannea, Dalbergia, Xylia and Lagerstroemia, tree species of Sacopetalum, Hopea, Sterculia, Pterocarpus, Pongamia, Bridelia, Dillenia, Holigarna, Syzygium, Mitragyna and Madhuca, also deserve special attention. Though Tectona grandis the teak does not occur wild it was possible to successfully introduce and cultivate on selected plots as seen from the forty-year old teak plantations at Valpoi which present satisfactory growth.

For extraction of fibre, oils, gums, etc. several species are known to yield suitable material. Species of Sarcostigma, Blumea, Guizotia, Carthamus, Mimusops, Origanum, Thymus, Santalum, Croton, Hitchenia, Vetiveria and Cymbopogon, are quite important as oil producing plants. Corchorus, Crotalaria, Calamus, Carvota are some of the fibre yielding plants whereas Sterculia is a good source of Karava gum used as a food preservative.

The grasslands of Goa harbour many economic fodder grasses which could be profitably utilised through proper farm management. The highly palatable fodder grasses, include species of Centotheca, Cynodon, Echinochloa, Hydrocotyza, Isachne, Digitaria, Setaria and Themeda. The common legumes that occur in this region are species of Desmodium, Geissaspis, Alysicarpus, Indigofera, Phaseolus, Sesbania, Smithia, Cassia, Vigna, Zornia and Tephrosia, which are well known for their forage value but in nature these do not occur in proper proportion. By selecting much of the indigenous rich legumes that are common in Goa and broadcasting the seeds during the early monsoon, the nutritive value of the fodder grass can be considerably enhanced.

The area is quite rich in medicinal plants. There is good possibility of introduction and cultivation of several useful species required by the pharmaceutical firms of Bombay who have already been planning for cultivation and pro-

pagation of specific medicinal plants. To mention a few, species like Nisalbombdi (Salacia chinensis), Itari (Rubia cordifolia), Akalkada (Spilanthes acmella), Tambdichitrak (Plumbago indica), Kudo (Holarrhena antidysenterica), Adki (Rauwolfia serpentina), Kawli (Gymnema sylvestre), Pitvel (Tylophora indica), Upas (Hemidesmus indicus), Kajro (Strychnos nux-vomica), Kanchi (Solanum nigrum), Dondalki (Withania somni-fera), Adoso (Adhatoda vasica), Kolaso (Hygrophila auriculata), Bhumi tulas (Ocimum basilicum), Carmalo (Coleus amboinicus), Alem (Zingiber officinale), Masalkanda (Curculigro orchioides), Sabro (Asparagus racemosus) and Vaghachyodavlyo (Gloriosa superba) well-known for their medicinal value, grow under natural conditions in Goa forests.

The flora of the region abounds in interesting species of botanical value both from the taxonomic as well as academic point of view especially for the student community. Quite a few species have been found to be new to the science like Manisuris goensis, Arthrason lancifolius var. hindustanicus and species of Fimbristylis, Oeropegia fantastica, a rare plant has been collected again after a lapse of over 50 years. Members of Podostemaceae like Polypleurum stylosum Griffithella hookeriana, Hydrobryopsis sessile, Terniola zeylanica and parasites like Aeginetia indica and species of Dendrophthe, Helixanthera, Helicanthes, Loranthus, Macrosolen and Viscum are quite interesting enough. Orchids species, both terrestrial and epiphytic, like Plantanthera, Habenaria, Liparis, Eulopia, Pholidota, Cymbidium, Dendorobium and Vanda, deserves special mention. The Pteridophyte flora is equally rich with species of Selaginella, Ophioglossum, Fibrosium, Angiopteris evecta, Acrostichum aureum, Schizoloma heterophyllum and several others.

Goa coast also abounds in the seaweed species belonging to various phyla. Although these marine algae species have been reported to have several interesting bioactive compounds and other chemical elements, these have not been used so far any medicinal use, inspite of their properties.

PHARMACOLOGICAL REVIEW.

A literature review of the Pharmacological and Phytochemical aspects of the Medicinal plants:- (PHARMACOLOGICAL REVIEW)

As in the past, to-day there has been greater emphasis on a search for plants with medicinal activity. Screening of plants for their pharmacological effect using animal models is continued from the past. However, the situation regarding well-planned clinical studies of plant products is not much satisfactory. Major laboratories like CDRI have resorted to a more broad based screening of plants. In spite of all these efforts however, the ultimate goal of providing potent, inexpensive and safer drug for most diseases encountered in our country still remains to be achieved. Certain important and useful leads, however, have certainly have been obtained during the years under review. Such examples are coleonol - a diterpenoid from Coleus forskohlii with hypotensive activity, spasmolytic sesquiterpenes from Cedrus deodata and spermicidal saponins from several plants. With the Alma Ata declaration of "Health for all by 2000 A.D." research in traditional medicine and ethno-pharmacology all over the world has received more attention from the Government of various countries as well as the World Health Organisation (WHO 1978). In this literature review, plants have been placed according to their pharmacological activities such as anti-inflammatory, anti-protozoal, anti-cancer, anti-fertility, anti-fungal, anti-hypertension, insecticidal, expectorant, uterine stimulant, anti-pyretic, oxytocic, anti-viral, cardiovascular, diuretic, purgative, anti-spasmodic, spasmodic, anthelmintic, hypoglycaemic, anti-bacterial, and CNS acting.

Plants having anti-inflammatory activity:

ICMR Bulletin (1972) described that the saponins from Hemidesmus indicus were found to be anti-inflammatory against formalin induced oedema. Dutta et al (1982) reported that ethyl acetate extract of this Plant exhibited significant anti-inflammatory activity in both acute and sub-acute methods of inflammation as

revealed by significant inhibition of inflammation induced by carrageenin, bradykinin, 5 hydroxy tryptamine, granuloma pouch and cotton pellet implantation method in rats. Singh et al (1978) reported that the ethanolic extract of the leaves of Hibiscus rosa-sinensis revealed anti-inflammatory activity against carrageenin induced rat paw oedema. Thirugmanasambantham et al (1982) reported that the aqueous and alcoholic extracts of Leucas aspera showed good activity in chronic antiinflammatory model. In acute model, however, the aqueous extract was more potent. Singh et al (1972) reported that alcoholic extract of the bark of Moringa pterygosperma showed activity against formalin induced rat paw oedema, cotton pellet implantation and granuloma pouch in doses of 500, 750 and 1000 mg per kg oral doses respectively in albino rats. Saxena et al (1984) reported that water soluble portion of alcoholic extract of leaves of Nyctanthes arbor-tristis showed significant activity against acute, subacute and chronic models of inflammation in rats. It inhibited acute oedema induced by different phylogistic agents such as carrageenin, formalin, histamine, 5-Ht and hyaluronidase in rat hind paw. It also induced inflammation swelling in the knee joint of rats induced by the intrasynovial injection of turpentine oil. The extractive significantly reduced the gramulation tissue formation in the cotton pellet test. The formaldehyde induced arthritis was also significantly inhibited in acute as well as chronic phase of inflammation. Chaturvedi & Singh (1965) reported that decoction of Paederia foetida given orally in a daily dose of 1.5 ml. (representing 0.75 gms of dry powder of drug) for 10 days showed significant activity against formaldehyde induced arthritis in non adrenalectomized albino rats. Sharma & Singh (1980) reported that decoction of whole plant of the above drug showed a mild degree of activity against carrageenin induced rat paw oedema. Bhalla et al (1968) & (1971) reported the activity of the Boerhaavia diffusa in albino rats. Bhalla et al (1971) also reported bio-chemical studies of this Plant. Mudgal (1974) also reported the same activity. Rai & Gupta (1966) reported the anti-inflammatory activity of Tinospora cordifolia in albino rats.

Plants having antiprotozoal activity:

Chopra et al (1927) and (1933) studied the antiprotozoal activity of total alkaloids of Holarrhena antidysenterica. Dutta & Iyer (1968) studied that various fractions of the above plant showed promising activity against experimental amoebiasis in rats & hamsters. Basu & Jayaswal (1968) reported that conessine from above plant was more active as an amoebicidal agent in vitro in comparison to other alkaloids of this plant as tested against the 'C' strain of Entamoeba histolytica. Bhakuni et al (1969) reported that the ethanolic extract (50%) of the whole plant of Murraya koenigii excluding roots has the activity against Entamoeba histolytica. Mishra & Sharma (1973) reported in uncontrolled clinical studies on 21 confirmed patients of intestinal amoebiasis for the drug of Oroxylum indigum that the oral administration of concentrated aqueous extract of powder drug led to symptomatic improvement as well as absence of Entamoeba histolytica cysts in stools in 19 patients.

Plants having anti-cancer activity:

Dhar et al (1968) reported that fruit extract (50%) ethanolic of Holarrhena antidysenterica is having anticancer effect against human epidermoid carcinoma of the nasopharynx in tissue culture. Dhawan et al (1980) reported that 50% ethanolic extract of Moringa pterygosperma excluding roots showed anti-cancer activity against human carcinoma and P 388 lymphocytic leukaemia in mice. Dhar et al (1968) reported that 50% ethanolic extract of leaves of Paederia foetida showed the above activity.

Plants having anti-fertility activity:

Batta & Santhakumari (1971) reported that benzene extract of Hibiscus rosa-sinensis flowers (100 mg per Kg.) revealed post-coital antifertility effect in female albino rats, leading to 80% reduction in the implantation site on the 10th day of pregnancy. The foetal loss in the rats was within the normal

range indicating the absence of any early abortifacient effect in the benzene extract. The petroleum ether extract was devoid of anti-fertility effect whereas the ether & ethanolic extracts of flowers did not show any significant activity. The benzene extract of flowers was found to be most active when administered as a dose of 250 mg/kg from day 1 to day 10 of pregnancy in rats. The petroleum ether and aqueous extracts failed to prevent pregnancy. The alcoholic extract however showed 50 to 70% activity in female rats in a dose of 250 mg/kg as reported by Kholkute & Udupa (1974 & 1976a). Further studies with the total benzene extract of the flowers of Hibiscus rosa-sinensis revealed to show anti-estrogenic activity in bilaterally ovariectomized immature albino rats, as reported by Kholkute & Udupa (1976 a). Kholkute & Udupa (1976b) reported that benzene extract of the above drug disrupted estrous cycle in rats depending on the dose and duration of treatment. The extract led to the reduction in the weights of ovary, uterus & pituitary. Ovaries showed follicular atresia & uterine atrophic changes. These effects could be reversed 30 days after withdrawal of plant extract. In an attempt to find the mechanism of action of its antifertility potential, Kholkute & Udupa (1976b) used various experimental models like administration of drugs during various embryonic stages of pregnancy, pontamine blue reaction and delayed implantation technique and showed that though the maximum anti-fertility activity is mediated via inhibition of implantation, invoking anti-implantation alone was not adequate to achieve full contraception & the drug also caused absorption of foetus. Prakash (1979a) studied the effect of 50% ethanolic and benzene extracts of flowers of Hibiscus rosa-sinensis on the estrogen dependent enzyme (acid & alkaline phosphatase) activity of rat uterus. He reported that a significant increase in acid phosphatase & decrease in alkaline phosphatase in both extracts was related to both enzymes. Prakash (1979 b,c) also further reported the antiestrogenic property of the ethanolic & benzene extracts in rats. Kholkute et al (1977) reported that flowers of Hibiscus rosa-sinensis collected in winter season showed the

maximum post-coital antifertility activity in female rat followed by those collected during rainy season. The activity was minimum in the flowers collected during summer. Setty et al (1977) reported that extract of Maesa indica whole plant excluding roots had a spermicidal activity in rats at 2% concentration but had no such effects on human semen at the same concentration. Banerji et al (1978) studied that saponin from Mimusops elengi seeds has spermicidal activity at a dilution of 0.06% in human semen. Prakash & Mathur (1976) reported that Moringa pterygosperma root extract (50%) ethanolic at a dose of 200 mg /kg led to foetal resorption in 60% female pregnant rats.

#### Plants having anti-fungal activity:

Bhatnagar et al (1961) studies that the roots of Hibiscus rosa-sinensis has anti-fungal activity against phyto-pathogen, Helminthosporium sativum. Deshmukh & Jain (1981) reported that the seed oil of Holarrhena antidysenterica showed an inhibitory effect against pathogenic keratinophilic fungi like Chryso-sporium indicum, C. pannicola, Malbranchea aurentiaca, Keratinomyces ajelloi, Microsporium gypsum. Maximum inhibition was noted against K.ajelloi & M.gypseum. Rao Narsimha & Rao (1972) reported that oil from Leucas aspera completely inhibited the growth of Epidermophyton floccosum even at concentration of 1:250. Thakur et al (1982) reported that chloroform extract of (0.5%) of the above plant was found to bring about the disappearance of clinical lesions in Trichophyton mentagrophytes, T. verrucosum, T. rubium & Microsporium gypseum dermatomycosis in mice and Thakur et al (1983) reported the above work against T. mentagrophytes in calves. Bhatnagar et al (1961) reported that bark extract of Moringa pterigosperma showed anti-fungal activity against Microsporium gypseum Trichophyton mentagrphtes, Candida albicans & Helminthosporium satisvum. Dhir et al (1982) reported in case of Pterocarpus marsupium that efficacy of this drug in the form of ointment as an anti-fungal agent was evaluated in a clinical trial on 50 patients suffering from dermatophyte infection i.e. Tinea cruris

(22 patients) T. corporis (14 patients) and mixed infection (14 patients). The ointment was locally applied for 7 to 10 days. The ointment made from alcoholic extract of wood was more effective than that prepared from aqueous extract of wood. Gupta & Bannerjee (1972) reported anti-fungal activity of Curcuma zedoaria. Satyaprakash et al (1972) reported anti-fungal activity of Eucalyptus globulus.

Plants showing anti-hypertension activity:

Dwivedi et al (1977) reported that the ethanolic extract of flowers of Hibiscus rosa-sinensis showed hypotensive effect in dogs. Agarwal & Shinde (1967) reported that glycosidic material isolated from leaves of Hibiscus rosa-sinensis showed hypotensive action in intact as well as spinal dogs. Jayshankar et al (1961) reported that in higher doses the alkaloid conkurchine Hydrochloride of Holarrhena anti-dysenterica lowered the dog blood pressure and dilated the rat blood vessels. It lowered the blood pressure of the atropinised dogs. Sharma et al (1978) reported that ethanolic extract (90%) of the fruit and the leaves of Mimusops elengi showed hypotensive effect in dogs. Singh et al (1976) reported that alcoholic extract of Moringa pterygosperma leaves caused an initial rise in blood pressure in mongrel dogs and cats followed by a gradual fall lasting for a considerable duration. Its action on blood pressure suggested the presence of a potent adrenergic neurone blocking substances in the alcoholic extract. Sabir et al (1974) reported that the alcoholic extract of leaves of Nyotanthus arbor-tritis showed hypotensive action in dogs. Bhakuni et al (1971) also reported the action of 50% ethanolic extract of Pterocarpus marsupium bark in cats and dogs. Iswariah et al (1954) reported this action in Rawolfia serpentina. There are many scientists who have reported hypotensive action in Rawolfia serpentina. They are Hamied et al (1956), Chakravarty et al (1951), Chakravarti (1953), Vakil (1953), Chowhan & Ghosh (1954), Gaitonde & Lewis (1955) and Dhawan & Bhargawa (1959). Patel & Dessai (1960) recorded that alcoholic extract of bark of Zanthoxylum rhetsa showed hypotensive effect.

Lahiri & Pradhan (1964) reported vasicinol alkaloid from Adhatoda vasica produced hypotension in cats.

Plants showing Insecticidal activity:

Srivastava et al (1983) reported the acetone extract of leaves of Memordica dioica proved toxic to the insect Euproctis lunata. Pandey et al (1982) published that the aqueous extract of leaves of Nyctanthes arbor-tristis is having strong insecticidal activity against painted bug. Mehta & Shidaskar(1967) studied insecticidal activity in Annona squamosa.

Plants having Expectorant activity:

Amin (1961) reported expectorant action of Alkaloid vasicinon from Adhatoda vasica. Lahiri & Pradhan (1964) also reported the same. Sabir (1974) reported that the alcoholic extract of leaves of Nyctanthes arbor-tristis had respiratory stimulant action in dogs.

Plants having Uterine activity:

Dhawan & Saxena (1958) reported the aqueous extract of pods of Helicteres isora showed a mild stimulant effect on spontaneous activity of isolated non gravid rat uterus. Misra et al (1966) studied Annona squamosa as uterotonic drug. Jethmalani & Gaitonde (1966) reported the uterine contraction action of ethyl acetate & alcoholic extracts of roots of Asparagus racemosus. Yoginder Nath (1962) studied the oxytocic principles from the seeds of Cassia tora.

Plants showing anti-pyretic activity:

Singh et al (1978) reported ethanolic extract of leaves of Hibiscus rosa-sinensis at a dose of 100 mg/kg. i.e. Hibiscus rosa-sinensis revealed a significant antipyretic effect against pyrexia induced by Brewer's yeast in the rat.

Plants showing antiviral activity:

Dhar et al (1968) reported the aqueous ethanolic extract of whole plant of Hemidesmus indicus (0.05 mg/ml) showed antiviral activity against Ranikhet disease (RDV) but was inactive against vaccinia virus. Babbar et al (1970) reported for the above plant in a dose of 75 mg/ml the extract was effective against both the viruses. Stem extract of Hemidesmus indicus and Cassia fistula inhibited the replication as well as cytopathic activity of both RDV & Vaccinia virus. Babbar et al (1982) studied both the above extracts for minimum concentration required for 100% viral inhibition and Hemidesmus indicus in concentration of 0.0125 mg/ml was effective against only RDV & not against Vaccinia virus. Singh & Singh (1972) reported the bark extract of Hibiscus rosasinensis having antiviral activity against potato virus X (PVX) inhibiting the viral multiplication by 60 - 79.9%. Tripathi & Tripathi (1982) reported that extract of Leucas aspera showed some anti-viral activity against bean common mosaic virus. Bhakuni et al (1969) reported that extract of whole plant of Maesa indica excluding roots revealed antiviral activity against Vaccinia virus. Bhakuni et al (1969) reported that 50% ethanolic extract of whole plant of Maesa indica exerted antiviral activity against vaccinia virus but was inactive against Ranikhet disease virus. Dhar et al (1968) reported 50% ethanolic extract of bark of Moringa pterygosperma showed activity against vaccinia virus but inactive against Ranikhet disease virus. Singh & Singh (1972) reported that bark extract of Nyctanthes arbor-tristis showed inhibition against potato virus X.

Plants showing Cardiovascular activity:

Dashputra et al (1977) reported that leaf extract of Moringa pterygosperma depressed action of the heart. Lahiri & Pradhan (1964) reported depression action of heart in guinea pig by <sup>i</sup>vascinol alkaloid from Adhatoda vasica. Neogi & Ahuja (1960) reported that bark extract of Nyctanthes arbor-tristis in higher doses had depression action on frogs' heart. Satoskar et al (1962) repor-

ted the aqueous extract of roots of Hemidesmus indicus showed an increase in Cardiac rate in rabbit. Roy et al (1968) reported that extracts of roots of Asparagus racemosus in low doses increase heart rate and higher doses cardiac arrest. Pandey & Sharma (1978) reported that decoction of bark of Pterocarpus marsupium showed hypocholesterolemic effect in rabbits.

#### Plants showing Diuretic activity:

Satoskar et al (1962) reported the aqueous extract of Hemidesmus indicus caused a light increase in urinary flow in rats but not in dogs. Dhawan et al (1977) reported that 50% ethanolic extract of whole plant of Leucos aspera had diuretic effect in rats. Pillai et al (1978) reported that decoction of leaf of Mimosa pudica showed moderate diuretic response in albino rats. Aswal et al (1984) reported that 40% ethanolic extract of whole plants excluding roots of Mimusops elengi showed diuretic action in rats. Gujral et al (1955) reported that decoction of bark of Oroxylum indicum showed good diuretic action in rats.

#### Plants having Antispasmodic activity:

Bhakuni et al (1969) reported 50% ethanolic extract of whole plant of Hibiscus rosa-sinensis excluding roots having antispasmodic action on guinea pig ileum. Dhar et al (1968) reported same action in fruit extract of Holarrhena antidysenterica. Bannerji et al (1982) reported that saponins from seeds of Mimusops elengi had spasmodolytic action on isolated guinea pig ileum against acetylcholine, histamine and barium chloride. It was most active against histamine. Banerjee et al (1982) reported antispasmodic activity in 50% ethanolic extract of whole plant of Mimusops elengi, and in Nyctanthes arbor-tristis. Bose et al (1968) reported that alkaloid aknadine and aknadinine from roots of Stephania hernandifolia showed antispasmodic effect on uterine spasm brought about by pituitary lobe extract. Dhar et al (1968) reported 50% ethanolic extract of leaves of Paederia foetida having the above effect.

Plants having Spasmodic activity:

Bhakuni et al (1969) reported that 50% ethanolic extract of whole plant of Helicteres isora excluding roots had a spasmogenic action on isolated guinea pig ileum. They also further reported the same action in Mimosa pudica. Dhar et al (1968) reported the same action in Moringa pterygosperma and also in fruits extract of Oroxylum indicum.

Plants having Anthelmintic activity:

Vijayalakshmi et al (1979) reported that the aqueous extract of seeds of Mimosa pudica showed nematicidal activity against the second stage juveniles of Meloidogyne incognita chitwood. They also reported the same action in plant of Mimosops elengi. Dhawan et al (1980) reported that the aqueous extract of Momordica dioica tuber showed anthelmintic activity against Hymenolepis nana. The extract did not show any activity against Nippostrongylus brasiliensis. Sabir et al (1974) reported that alcoholic extract of leaves of Nyctanthes arbor-tristis produced paralysis in intact Ascaridia galli worms. Roychowdhury et al (1970) reported that the juice of the leave of Paederia foetida showed potent anthelmintic effect against bovine helminthis viz. Strongyloides sp., Trichstrongylus sp., Haemonchus sp. (100%), Bunostomum sp. & Moniezia sp. (50 - 70%) in young calves.

Plants having Hypoglycaemic activity:

Dhar et al (1968) reported the fruit extract (50% ethanolic) of Holarrhena antidysenterica showed hypoglycaemic activity in rats. Narayana & Sastry (1975) reported that aqueous extract of leaves of Murraya koenigii showed hypoglycaemic activity in normal & alloxan diabetic dogs. Joglekar et al (1959) studied glucose absorption from the gastro-intestinal tract in mice which were administered Pterocarpus marsupium aqueous extract for 15 days. Reduced glucose absorption observed in Pterocarpus marsupium extract treated mice was attributed

to non-specific action of tannates. This finding was confirmed by Gupta (1963 a,b) who studied the effect of Pterocarpus marsupium wood (aqueous infusion) on glucose tolerance in albino rats. Khandare et al (1983) in a preliminary study found that chronic administration of wood powder of the above drug for 5 days claimed to check blood sugar level in rats after a glucose load. Haranath et al (1958) reported that Pterostilbine derived from the wood of above drug (10 mg/kg) administered intravenously to dogs produced a fall in blood sugar. Higher doses of (20, 30, & 50 mg/kg) led to an initial hyperglycaemia followed by hypoglycaemia lasting for nearly 5 hours. Pandey & Sharma (1976) reported that the decoction of the bark of above drug administered orally 4 gm/100 g body wt/day for 10 day showed a hypoglycaemic action in rats which were rendered diabetic by alloxan. Gupta et al (1963b) reported aqueous infusion of bark of above drug to inhibit in the third hours the acute hyperglycaemic response induced by the anterior pituitary extract in glucose fed albino rats. Trivedi (1963) reported the aqueous extract of bark of above drug to have hypoglycaemic effect in both in acute and chronic experiments on normal rabbits. The aqueous extract was more potent than alcoholic fraction. Shah (1967) and Saifi et al (1971) reported the hypoglycaemic action of the above drug in normal rabbits. Chakravarthy et al (1980) reported in a series of studies carried out in rats that this drug has a novel antidiabetic mechanism as revealed by pancreatic B-Cell regeneration by flavonoid fraction. Dharmadhikari et al (1984) while confirming the hypoglycaemic action of the above drug thought that the action may be partly due stimulation of insulin secretion from B-Cells of pancreas and partly due to decreased absorption from the gastro intestinal tract. Gupta et al (1967a) studied antidiabetic effect of Casearia esculenta. Nantiyal (1968) also studied Casearia esculenta in the treatment of diabetes mellitus. Kashyap & Ahuja (1968) did the clinical work on hypoglycaemic activity of the above drug. Brahmachari & Augusti (1964) reported isolation of orally effecting hypoglycaemic compounds from Ficus bengalensis. Brahmachari & Augusti (1961) reported hypoglycaemic effect of seeds of Eugenia jambolana

and bark of Ficus bengalensis. Lal & Choudhuri (1968) reported antidiabetic effect of Eugenia jambolana. Deshmukh et al (1960) studied on hypoglycaemic effect of Ficus bengalensis. Chaudhury et al (1961) reported hypoglycaemic effect of bark of Ficus bengalensis. Vhora & Parasar (1970) reported antidiabetic studies on Ficus bengalensis. Sepha & Bose (1956) did clinical observation on the antidiabetic properties of Pterocarpus marsupium and Eugenia jambolana. Shah (1967) did a preliminary study of hypoglycaemic action of Pterocarpus marsupium. Trivedi (1971) reported antidiabetic properties of alcoholic extract of heartwood of Pterocarpus marsupium. Modak and Rajaram Rao (1966) studied hypoglycaemic activity of a non-nitrogenous principle from the leaves of Adhatoda vasica. Gupta et al (1967b) reported hypoglycaemic effect of Tinospora cordifolia. Raghunathan & Sharma (1969) also reported the same.

#### Plants having antibacterial activity:

ICMR Bulletin 1972 reported petroleum ether, chloroform & alcoholic extracts of roots of Hemidesmus indicus having antibacterial activity against Staph. aureus, S. albus, Sal. typhosa, Vib cholerae, E. coli, Sh. shigae, Sh. flexneri & Sh. sonnei. Prasad et al (1983) reported the essential oil obtained from the above plant exhibited marked antibacterial activity against B. proteus, Ps. aeruginosa, Staph. pyogenes & E. Coli at a concentration of 0.2%. Bhatnagar et al (1961) reported bark extract of Leucas aspera having antibacterial activity against E. coli, Sal. typhosa, Vib. comma & Sh. dysenterica. Gaiind & Bappa (1967) reported antibacterial effect of roots of Thespesia populnea. Saḡyanarayana et al (1977) reported the leaf extract of Mimusops elengi having antibacterial activity in vitro against B. antracis, B. mycoides, B. pumilus, B. subtilis, Sal. paratyphi, Staph. albus, Vib. cholerae, Xanth. campestris & Xanth. malvacearum. The inhibition being significant against Zanth. campestris and B. antracis. Bhavsar et al (1965) reported that the juice of leaf & bark of Moringa pterygosperma inhibited Staph. aureus but not E. coli. Vhora

et al (1975) reported anti-bacterial effect of Annona squamosa. Rao & Kurup (1953) studied on antibiotic principle Pterygospermine from roots of Moringa Pterygosperma. Goutam & Purohit (1974) reported anti-microbial activity of essential oil of leaves of Murraya koenigii against B. subtilis, Staph. aureus, C. pyogenes, P. vulgaris & Pasteurella multocida. The pure oil was active against the first three organism even at a dilution of 1 : 150. Patel & Patel (1956) studied antibacterial effect of Cassia fistula. Satyaprakash et al (1972) reported antibacterial effect of oil of Eucalyptus globulus. Sengupta et al (1956) reported antibacterial effect of Moringa pterygosperma. Das et al (1957) and Das & Rao (1958) reported the same work. Joshi & Magar (1953) reported antibacterial effect of Zanthoxylum rhetsa.

#### Plants acting on Central Nervous system:

Bhakuni et al (1969) reported that the ethanolic extract of Hibiscus rosa-sinensis (50%) showed depressant effect on CNS. It produced hypothermia and potentiated barbiturate induced hypnosis in mice. Dhawan et al (1977) reported that (50%) ethanolic extract of whole plant of Leucas aspera revealed CNS depressant action in mice. Bhakuni et al (1969) reported the same action in Nyctanthes arbor-tristis. Dhar et al (1968) reported the work in Paederia foetida. Neogi & Ahuja (1960) reported that glycoside isolated from the bark of Nyctanthes arbor-tristis having CNS depressant action. Gaitonde & Lewis (1955) reported that alkaloids from roots of Rawolfia serpentina had vasodilatory & central sedatory effect.

## LITERATURE REVIEW (PHYTOCHEMICAL REVIEW)

The living organism may be considered a bio-synthetic laboratory not only for chemical compounds (carbohydrates, proteins & fats) that are utilised as food by men and animals but also for multitude of compounds (glycosides, alkaloids, volatile oils) that exert a physiologic effect. These chemical compounds give plant and animal drugs their therapeutic properties. Drugs are either used as such in their crude form or they may be extracted, the resulting principles being employed as medicinal agents. The usual term for these principles or chemical entities is constituents. But since plant or animal is composed of many chemical compounds it is common practice to single out those compounds that are responsible for therapeutic effect and call them active constituents. These active constituents are differentiated from inert constituents which also occur in plant and animal drugs. Cellulose, lignin, suberin & cutin are regarded as inert matters in plant drugs, in addition starch, colouring matter and other substances which have no definite pharmacologic activity are also considered as inert substances. In animal drugs, Keratin, chitin, muscle fibre and connective tissue are regarded as inert substances. This chapter is devoted to these active constituents and accordingly the plants containing such active constituents have been exemplified viz. alkaloids, flavonoids, steroids, glycosides, isoprenoids, saponins, tannins, esters, organic acids & amino acids and other organic compounds.

### Alkaloids

Verma et al (1967) reported the presence of alkaloid in leaves of Hibiscus rosa-sinensis. Chaturvedi et al (1980 & 1981) reported 29 alkaloids in Holarrhena antidysenterica. Khorana & Vasudevan (1967) reported variations in content of alkaloids in market samples of Holarrhena antidysenterica. Jayaswal & Basu (1967) & Khorana & Vasudevan (1967) described method for estimation of conessine in bark preparation of the above drug. Thakkar et al (1972) described method employing ultrasonic energy for extraction of alkaloid from

the above drug. Rej et al (1976) isolated new steroidal alkaloid 20 S-acetamide - 5 -  $\alpha$  - pregnan - 3 -  $\beta$  - ol, in addition to conessine in bark of the above drug. Gupta et al (1976) identified alkaloids in leaves of Mimosa pudica. Chakraborty et al (1964, 1965 & 1966) reported that stem bark of Murraya koenigii on extraction of petroleum ether gave carbazole alkaloid, girinimbine, murrayanine (1 - methoxy - 3 - formylcarbazole) and mahanimbine respectively. Roy and Chakraborty (1974) isolated optically inactive mahanimbine from extract of Murraya koenigii. Chakraborty & Das (1968) and Chakraborty et al (1971) isolated murrayanine alkaloid from Murraya koenigii. Spectroscopic, degradative & synthetic evidences have been documented for girinimbine as published by Dutta & Quasim (1969), Narasimhan et al (1970a), Kureel et al (1970a), Chakraborty & Islam (1971), Joshi et al (1970); for murrayanine as published by Chakraborty et al (1965), Chakraborty & Chowdhury (1968); for mahanimbine as published by Joshi et al (1970), Narasimhan et al (1968), Chakraborty et al (1969), Narasimhan et al (1970a, 1975 and 1976); for murrayanine as published by Chakraborty & Das (1968), Chakraborty et al (1971) & (1973), Anwar et al (1973), Joshi et al (1970) and for mukanol as published by Bhattacharyya & Chakraborty (1984)•

The other carbazole alkaloids isolated from the stem bark were murrayazolidine as reported by Chakraborty et al (1970); murrayanine as published by Chakraborty et al (1974); iso-murrayazoline published by Bhattacharya et al (1982); curryanine, curryangin as published by Dutta et al (1969), Narasimhan & Kelkar (1976), & murrayazoline published by Bordner et al (1972). Narasimhan et al (1968 & 1975) recorded that Murraya koenigii fruits yielded a new alkaloid koenimbine. Kureel et al (1969) reported that leaves of Murraya koenigii yielded a number of alkaloids including a new alkaloid koenigicine apart from koenimbine, cyclomahanimbine, bio-cyclomahanimbine & mahanimbidine. Joshi et al (1970) reported that the hexane extract of the above drug yielded mahanimbine,

girinimbine & 2 new alkaloids iso-mahanimbine & koenimbidine. Kureel et al (1970b) reported that the leaves yielded mahanimbine. Narasimhan et al (1970a, b & 1975) reported that the leaves of above drug yielded mahanimbine and new alkaloids mahanine, koenine, koenigine & koenidine. Gupta & Nigam (1970) isolated carbazole alkaloid murrayanine from the leaves of the above drug. Mukherjee et al (1983) reported that the leaves of above drug yielded a new carbazole alkaloid mukonidine. Roy et al (1979) reported that the roots of the above drug on extraction with light petroleum gave a carbazole alkaloid mahanimboline. Joshi et al (1970) reported that hexane extract of roots of above drug yielded girinimbine. Roy et al (1982) reported that benzene extract of the above drug yielded 2 new carbazole alkaloids, mukoline & mukolidine. Moza (1967) isolated isoquinoline alkaloid aknadine from roots & rhizomes of Stephania hernandifolia. Moza & Basu (1967) isolated alkaloids from roots of Stephania hernandifolia. Bose (1954) isolated alkaloid rauwolfine from roots of Rauwolfia serpentina. Chakraborty & Das (1966) reported a new carbazole derivative from Glycosmis pentaphylla. Bhaumik et al (1979) studied on alkaloids of leaves of Annona squamosa. Jain et al (1980) reported an novel non-harmal alkaloid from Adhatoda vasica. Dhar et al (1981) reported vasicol, a new alkaloid from above drug. Siddiqui et al (1987a) reported azmalicidine alkaloid from Rawolfia serpentina. Chowdhury et al (1987) isolated carbazole & 3-methyl carbazole from Glycosmis pentaphylla. Bhattacharya et al (1985) reported glycozolidol, carbazol alkaloid from Glycosmis pentaphylla. Bhattacharyya & Chowdhury (1985) reported glycolone, quinolone alkaloid from above drug. Chowdhury & Bhattacharyya (1984) reported quinazoline alkaloid from Adhatoda vasica.

#### Flavonoids

Subramanian & Nair (1968) reported flavonoid glycosides in flowers of Hemidesmus indicus as hyperoside, isoquercetin, & rutin and in leaves only hyperoside and rutin. Subramanian & Nair (1972d) reported quercetin - 3 diglucoside & cyanidin - 3 - sophoroside - 5 - glucooside in flowers of Hibiscus rosa-sinensis. Subramanian & Nair (1971) reported two flavonoids rutin and kaempferol -

3 - rutinoside in leaves & flowers of Ixora parviflora. Misra & Mitra (1967b) reported in ethanolic extract of Mimusops elengi seeds, quercitol, dihydro-quercetin, quercetin and in flowers quercitol. Singh et al (1965) reported that ethanolic extract of leaves of Nyctanthes arbor-tristis contained astragelin (kaempferol - 3 - glucoside) and mlotiflorin (kaempferol - 3- rhamno-glucoside). Mitra & Joshi (1983) reported isoflavonoid from heart-wood of Pterocarpus marsupium. Parthasarathy et al (1979) reported NMR studies of flavono-lignans from Hydnocarpus wightiana. Subramanian & Nair (1972a) reported that ethanolic extract of Oroxylum indicum leaves gave baicalein & scutellarein from its ether fraction; a flavone glycoside identified as baicalein - 6 - glucuronide from its ethyl acetate fraction & two glucuronides and scutellarein - 7 - glucuronide (scutellarein) & baicalein - 7 - glucuronide (baicalein) from aqueous mother liquor. Subramanian & Nair (1972b) reported that ethanolic extract of bark of Oroxylum indicum yielded oroxylin, baicalein & scutellarein from ether fraction and scutellarein - 7 - rutinoside, from ethyl acetate fraction. Chrysin & baicalein - 7 - glucuronide, occurred in mother liquor of ether & ethyl acetate fractions. Joshi et al (1977) reported that flavone is present in benzene extract of heartwood of Oroxylum indicum. Mehta & Mehta (1959) reported that baicalein-6-glucoside was present in ethanolic extract of defatted seeds of Oroxylum indicum. Nair & Joshi (1979) reported new flavone oroxindine flavone from ethanolic extract of seeds of Oroxylum indicum. Adinarayana et al (1982) reported that Pterocarpus marsupium roots yielded a new C - glycosyl -  $\beta$  - hydroxydihydro-chalkone, pterosupin, apart from pseudobaptigenin, liquiritigenin, isoliquiritigenin, garbanzol, 5 deoxykaempferol. Sawhney & Seshadri (1956) reported that alkali soluble portion of Pterocarpus marsupium heartwood yielded isoliquiritigenin & liquiritigenin. Subbarao & Mathew (1982) isolated from ether extract of the above drug a novel isoflavonoid glycoside, marsupol. Mathew & Subbarao (1983) isolated from the above drug a novel 2 - hydroxy - 2 - benzyl coumaranone

named carpusin. Trivedi (1971) isolated marsupinol from ethyl acetate fraction of alcoholic extract of heart-wood of Pterocarpus marsupium. Mitra & Joshi (1982) isolated from the above drug a new isoflavone glycoside characterised as 5, 4'-dimethoxy - 8 - methylisoflavone - 7 - O -  $\alpha$  - L - rhamnopyranoside along with a retusin - 7 - O -  $\beta$  - D - glucopyranoside & irisolidone - 7 - O -  $\alpha$  - L - rhamnopyranoside. Mitra & Joshi (1983) isolated from the above drug a new isoflavone identified as 5, 7 - dihydroxy - 6 - methoxy - 7 - O -  $\beta$  - L - rhamnopyranoside. Maurya et al (1984) reported that ethyl acetate extract of the above drug gave 7 hydroxy flavanone, isoliquiritigenin, liquiritigenin, 7, 4 - dihydroxy flavone, 5 deoxykaempferol & 3, 7, 4 tri-hydroxy flavone. Reddy (1968) isolated a novel type leucoanthocyanidin, fista-cacidin from sap wood of Cassia fistula. Govindachari et al (1969) isolated flavone from roots of Andrographis paniculata. Bhatia et al (1969) isolated a proanthocyanidin containing 9 phenolic & 4 alcoholic OH groups from bark and heartwood of Tamarindus indica. Datta et al (1972) isolated pigment gossypol from bark & flowers of Thespesia populnea. Jain & Seshadri (1975) isolated anthocyanins delphinidine - 3 - gentiobioside and malvidine from fruits of Eugenia jambolana. Kewis & Johar (1956) isolated pigment cynidine from seeds of Tamarindus indica. Bhatia et al (1964) isolated C-type flavonol glycoside from leaves of Tamarindus indica. Subramaniyan & Nair (1969a) isolated flavanoid hyperoside from leaves, flowers and fruits of Asparagus racemosus. Aiyer & Seshadri (1972) isolated flavonoids from Groton oblongifolius. Subramaniyan & Nair (1972c) isolated myricetin - 3 - L arabinoside & quercetin - 3 - glucoside & 3 galactoside from flowers of Eugenia jambolana. Bhargava et al (1974) isolated Kaempferol - 3 - O - glycoside & quercetin from bark of Eugenia jambolana. Sen & Singh (1964) isolated Kaempferol glycoside from leaves of Nyctanthes arbor-tristis. Mitra & Joshi (1982) isolated isoflavone glycoside from heartwood of Pterocarpus marsupium.

#### Steroids

Chatterjee & Bhattacharyya (1955) reported  $\beta$ -sitosterol in roots of

Hemidesmus indicus. Agarwal & Rastogi (1971) reported taraxeryl acetate and  $\beta$ -sitosterol in Hibiscus rosa-sinensis leaves. Wahi et al (1973) reported 3 sterols from above drug. Verma et al (1967) reported presence of sterols in the above drug. Narayanan & Naik (1981) reported steroid, sitosta - 5, 23 dien - 3  $\beta$  - ol from bark extract of Holarrhena antidysenterica. Aditya-Chaudhury & Ghosh (1969) reported  $\beta$ -sitosterol in petroleum ether extract of above drug. Jain & Bholu Nath (1968) & Badami & Patil (1975) reported  $\beta$ -sitosterol from seeds of above drug. Desai et al (1973) reported  $\beta$ -sitosterol from hexane extract of Maesa indica whole plant and also reported the same in Mimosa pudica seeds. Misra & Mitra (1967b) reported  $\beta$ -D-glucoside of  $\beta$ -sitosterol &  $\alpha$ -spinasterol in seeds of Mimusops elengi. Sinha (1962) reported  $\beta$  &  $\gamma$  - sitosterol in seeds of above drug. Mishra & Mitra (1967b) reported in hexane soluble fraction of the alcoholic extract of the above drug to yield taraxerol,  $\alpha$ - spinasterol & in hexane insoluble fraction -  $\beta$  - D - glucoside of  $\beta$ -sitosterol. Bahl et al (1968) reported in petroleum ether extract of bark of Mimusops elengi  $\alpha$ - spinasterol & taraxerol. Misra & Mitra (1968) reported that the ethanolic extract of heartwood of Mimusops elengi yielded lupeol &  $\alpha$ -spinasterol while hexane soluble fraction gave  $\beta$ -sitosterol. Gupta et al (1976) reported in flowers of the above drug  $\beta$ -sitosterol &  $\beta$ -sitosterol -  $\beta$  - D - glucoside. Misra & Mitra (1968) reported in roots of the above drug taraxerol, spinasterol & 1 - D glucoside of  $\beta$ -sitosterol. Saluja et al (1978) reported that benzene extract of Moringa pterygosperma yielded  $\beta$ -sitosterol while hexane extractive gave  $\beta$ -sitosterone & octacosanoic acid in addition to  $\beta$ -sitosterol. Sen & Singh (1964) reported that Nyctanthes arbor-tristis leaves showed presence of  $\beta$ -sitosterol. Khastgir et al (1960) reported that Oldenlandia corymbosa contained  $\gamma$ -sitosterol. Joshi et al (1977) reported that benzene extract of Oroxylum indicum yielded  $\beta$ -sitosterol. Tripathi & Dasgupta (1974) reported that petroleum ether extract of Paederia foetida gave sitosterol. Subramanian & Nair (1969 b) reported diogenin in Asparagus racemosus leaves.

Bhargava et al (1974) reported  $\beta$ -sitosterol and its glycoside in bark of Eugenia jambolana. Gupta & Behari (1973) reported  $\beta$ -sitosterol in acetone soluble fraction of seeds of Vitex negundo. Sen & Singh (1964) reported the same in the leaves of Nyctanthes arbor-tristis. Karmarkar & Chakraborty (1983) reported 7-dehydrositosterol from Rawolfia serpentina. Mahato et al (1967) reported taraxerol from Careya arborea.

#### Glycosides

Verma et al (1967) reported presence of glycosides in leaves of Hibiscus rosa-sinensis. Gupta & Nigam (1970) reported a coumarinic glycoside, scopolin in leaves of Murraya koenigii. Chauhan & Saraswat (1978) reported glycoside naringenin - 4 - O -  $\beta$  - glucopyranosyl - xylopyranoside in alcoholic extract of Nyctanthes arbor-tristis. Day et al (1978) reported anthraquinone glycoside of aloe-emodin in leaves of Oroxylum indicum. Raghunathan et al (1974) isolated anthraquinone glycoside chrysophanol 1 -  $\beta$  - gentiobioside from seeds of Cassia tora. Modi & Khorana (1952) reported anthraquinone derivative rhein from Cassia fistula. Narayanan & Rangaswamy (1957) reported 3 crystalline substances tora A, tora B & tora C from seeds of Cassia tora. Kazi et al (1965) isolated anthraquinone glycoside rhein from fruits of Cassia fistula. Shah & Shinde (1967) reported anthraquinone glycoside of rhein, aloe-emodin & chrysophanol from seeds of Cassia tora. Kazi et al (1968) reported anthraquinone glycoside of rhein, sennoside A & B from leaves of Cassia fistula. Mehta & Mehta (1953) reported tutin, a glycoside from seeds of Oroxylum indicum. Kazi & Khorana (1964) reported anthraquinone glycoside in leaves of Cassia fistula. Sehgal et al (1983) reported 6 - P - hydroxy-benzoyl ussaenosidic acid - iridoid glycoside from Vitex negundo.

#### Isoprenoids

Narayanan & Naik (1981) reported a new triterpene, lupadien 3- $\beta$ -ol

from Holarrhena antidysenterica bark. Anjaneyulu et al (1965) reported triterpenoid, barynenol in hexane extract of bark of Moringa pterygosperma. Bhattarcharjee and Das (1969) reported terpenes in bark of Moringa pterygosperma. Das (1965) reported  $\alpha$  &  $\beta$  carotene, in ether extract of leaves of above drug. Agarwal & Rastogi (1971) reported triterpenoids of Hibiscus rosa-sinensis. Adinarayana & Syamsunder (1982) reported a new sesquiterpene alcohol, sellin - 4(15) - en -  $\beta$  - 11 - diol, besides eudesmol, erythrodiol - 3 - monoacetate in roots of Pterocarpus marsupium. Barua et al (1969) reported lactic acid - a new triterpene from Lantana camara. Macleod & Pieris (1982) described the method of analysis of volatile oil of Murraya koenigii. Gaydon & Randriamiharison (1987) isolated hydrocarbon from essential oil of Cymbopogon martinii. This hydrocarbon represented 11 monoterpenes, 28 sesquiterpenes & 16 n - alkanes. The major constituents were limonene,  $\alpha$ - terpinene, myrcene, caryophyllene,  $\alpha$ - humulene,  $\beta$ -selinenes. Dutta (1960) reported essential oil of Lantana camara. Bottini et al (1987) isolated dihemiacetal bis-monoterpenoid from Cymbopogon martinii. Siddiqui et al (1987b) isolated withanolide daturilin from alcoholic extract of leaves of Datura metel. Padhey et al reported triterpenoid from roots of Hemidesmus indicus. Hanuman et al (1986) isolated diterpenoid furanolactone from Tinospora cordifolia, stem. Shiobara et al (1986) isolated zedoarol, 13-hydroxygermacrone & curzeone, sesquiterpenoids from Curcuma zedoaria rhizome. Dutt (1958) reported that essential oil from leaves of Murraya koenigii yielded dl -  $\alpha$ - phellandrene, d-~~S~~abinene, d -  $\alpha$ - pinene, dipentene, caryophyllene and cadinene. Nigam & Purohit (1961a, b) reported that oil of above drug showed presence of 1 -  $\alpha$ - pinene, 1 - sabinene, dipentene, 1-terpinol, 1 - caryophyllene & 1 - cadinene. Chandra (1970) reported that oil from Nyctanthes arbor-tristis flowers contained  $\alpha$ - pinene & p.oymene, 1 - hexanol, methyl heptanone, phenyl acetaldehyde, 1 - decanol & anisaldehyde. Dhingra et al (1976) reported that acetone extract of corolla tubes of Nyctanthes arbor-tristis yielded  $\beta$ -monogentiobioside ester of  $\alpha$ - crocetin as a major component &  $\beta$ -digentiobioside ester of  $\alpha$ - crocetin as minor component. Aiyar et al (1969) isolated diterpene alcohol,

deoxyoblongifoliol from bark of Croton oblongifolius. Aiyar & Seshadri (1971a) isolated from the above drug diterpenes such as entisopinara - 7 - 15 - diene, its alcohol i.e. 19 - hydroxy entisopinara - 7 - 15 - diene, entisopinara - 7 - 15 - diene. Aiyar & Seshadri (1971b) isolated triterpene acid acetyl aleuritic acid from bark of above drug and Aiyar & Seshadri (1971c) isolated diterpene oblongifoliol & deoxy-oblongifoliol from the above drug. Anjaneyulu and Ramachandra Row (1968) studied the triterpenes of Calotropis gigantea. Mahato & Dutta (1974) isolated triterpenoid careyagenol from seeds of Careya arborea. Sengupta & Das (1965) isolated two triterpene acids oleanolic acid & crategolic acid (maslinic acid) from flowers of Eugenia jambolana. Rai & Muthana (1954) isolated essential oil from leaves of Annona squamosa.

#### Saponins

Kapoor et al (1971) isolated saponins from root and bark of Helecteres isora but found to be absent in leaves and flowers. Varshney & Logani (1969) isolated saponins from ethanolic extract of bark of Mimusops elengi and on hydrolysis it gave  $\beta$ -amyrin & bassic acid. Padhey et al (1973) isolated from Hemidesmus indicus lupeol,  $\beta$ -amyrin &  $\alpha$ -amyrin. Rao (1950) isolated, sapogenin, sarsasapogenin from roots of Asparagus racemosus. Sen & Singh (1964) isolated  $\beta$ -amyrin from leaves of Nyctanthes arbor-tristis. Das & Mahato (1982) reported triterpenoid saponins from leaves of Careya arborea.

#### Tannins

Atal et al (1978) reported absence of tannins in whole plant of Helecteres isora. Daniel et al (1978) reported 2.5% of tannins in leaves of Hemidesmus indicus. Atal et al (1978) reported presence of tannins in 50% alcoholic extract of whole plant excluding roots of Ixora parviflora. They also reported presence of tannins in whole plant excluding roots of Maesa indica. Sawhney & Seshadri (1956) reported epicatechin in bark of Pterocarpus maraupium. Datta et al (1971) isolated a phenolic substance populneol from flowers of Thespesia populnea.

### Esters

Singh et al (1984) reported in the leaves of Helicteres isora, a new ester characterised as tetratriacontanyl, tetratriacontanoate along with tetratriacontanoic acid & tetratriacontanol. Padhey et al (1973) isolated a new ester identified as lupeol octacosanoate in Hemidesmus indicum in addition to lupeol acetate &  $\beta$ -amyrin acetate. Desai et al (1971) reported that hexane extract of Paederia foetida (whole plant) yielded epifrandelinol acetate. Govindachari et al (1971) isolated ester cluytyl ferulate from roots of Gmelina arborea. Gambhir & Joshi (1952) isolated glycerides of linolenic, linoleic, oleic, palmitic & stearic acids from seeds of Abutilon indicum. Nakatani et al (1986) isolated four aliphatic esters from bark of Hibiscus rosa-sinensis and characterised as methyl 10 - oxo - 11 - octadecynoate, methyl 8 - oxo - 9 - octadecynoate, methyl 9 - methylene - 8 - oxo - heptadecanoate & methyl 10 - methylene - 9 - oxo - octadecanoate. Oberao et al (1983) reported a pregnane ester diglycoside from Hemidesmus indicus.

### Organic Acids & Amino Acids

Srivastava (1974 & 1976) reported two cyclic acids sterculic acid and malvalic acid in leaves of Hibiscus rosa-sinensis. Thanki & Thaker (1980) reported 15 amino acid, aspartic acid & arginine being the dominant ones among them in seeds of Holarrhena antidysenterica. Daulatabad & Nkalagi (1982) reported capric, lauric, myristic, palmitic, stearic, arachidic, behenic, oleic & linoleic acids in seed oil of Ixora parviflora. Adityachoudhury & Ghosh (1969) reported oleanolic acid & ursolic acid in petroleum ether extract of whole plant of Leucas aspera. Jain & Bhola Nath (1968) and Badami & Patil (1975) reported that petroleum ether extract of seed of Leucas aspera gave palmitic, stearic, oleic, linoleic & linolenic acids. Sinha (1962) reported fatty acids in oil in seeds of Mimusops elengi. Ghosh et al (1981) reported a new lectin in cotyledonary tissues of Momordica dioica. Das (1965) reported aspartic acid, glutamic acid, serine, glycine, ~~α~~ alanine, leucine, histidine, lysine, arginine, cystine & me-

thionine, in leaves of Moringa pterygosperma. Ramiah & Nair (1977) identified 9 amino acids in flowers, 8 in fruits and 7 each in protein hydrolysate of flowers and fruits of above drug. Alanine, arginine, glutamic acid, glycine, serine, threonine & valine were common in all parts tested, whereas aspartic acid was present in flowers as well as in fruits and lysine in flowers of the above drug. Subba Rao et al (1953 a, b) reported that seed oil of Moringa pterygosperma contained palmitic, stearic, behenic and oleic acids. Chowdhury & Chakraborty (1971a) that alcoholic extract of Murraya koenigii stem yielded mukoeic acid i.e. 1-methoxy carbazole - 3 carboxylic acid. Chakraborty et al (1978) reported methyl ester of mukoeic acid from petrol extract of bark of above drug. Khastgir et al (1960) reported that Oldenlandia corymbosa yielded oleanolic acid and ursolic acid. Sunderaramaiah & Vimalabai (1973) reported oleanolic acid from the roots of Lantana camara. Gupta & Bihari (1973) reported that alcoholic extract of seeds of Vitex negundo gave carboxylic acid.

#### Other Organic Compounds

Padhey et al (1973) isolated hexatriacontane from Hemidesmus indicus. Anjaneyulu et al (1965) isolated the same from roots of the same drug. Dessai et al (1975) isolated maesaquinone from acetone extract of seeds of Maesa indica. Saluja et al (1978) reported that benzene extractive of ethanolic extract of Moringa pterygosperma yielded 4 - hydroxy mellein & vanillin. Gopalan et al (1984) reported that the different parts of the above drug contained minerals and vitamins. Lal & Dutta (1933) reported that leaves of Nyctanthes arbor-tristis contained D - mannitol. Sen & Singh (1964) reported  $\beta$ -amyrin, hentriacontane & benzoic acid in the above drug. Bose et al (1953) reported methyl mercaptan in Paederia foetida. Subba Rao et al (1984) isolated propterol from Pterocarpus marsupium. Mauriya et al (1982) isolated from ethyl acetate extract of the above drug a new compound named as marsupin, characterised as 2 hydroxy - 2 benzyl - 3 (2 H) benzofuranone. Pai et al (1970) isolated crotepoxide in tubers of Kaempferia rotunda. Mehta et al (1960) isolated lupeol

from bark of Zanthoxylum rhetsa. Shastri & Mahadevan (1963) isolated lantadenes from leaves of Lantana camara. Krishnan & Rangaswami (1965) isolated leucopelargonidin from roots of Casuarina esculenta. Gupta & Behari (1973) reported a mixture of n - alkanes containing n - triacontane from acetone insoluble extract of seed of Vitex negundo. Vishnoi et al (1983) reported furanoermophilane from Vitex negundo. Agarwal et al (1972) reported fistulic acid a new colouring matter from pods Cassia fistula. Venkata Rao et al (1967) reported luteolin in leaves of Gmelina arborea. Govindachari et al (1972) reported arboreol, a new lignan from Gmelina arborea.

CHAPTER II  
MATERIALS AND METHODS

CHAPTER - IIMATERIALS AND METHODS

This chapter deals with the materials used for the pharmacognostic study as well as the different methods employed for chemotaxonomy, microscopical characters, phytochemical tests and methods. In all 70 herbal samples were collected from the forest of Morlem, Sattari Taluka, Goa (India). The materials consisted of different parts of the medicinal plants as given in the following table. The photographs of some of these drugs are shown on plates mentioned against their Parts. However, one promising plant Maesa indica was selected and the roots of this plant were studied for phytochemical analysis as a case study.

The table 1 gives the list of the medicinal plants collected and the part or parts studied.

TABLE - 1

<u>Botanical name</u>	<u>Part/Parts studied</u>
1. <u>Boerhaavia diffusa</u> , Linn	Herb
2. <u>Momordica dioica</u> , Roxb.	Root
3. <u>Viburnum foetidum</u> , Wall	Root (Plate I-A)
4. <u>Mimusops elengi</u> , Linn.	Bark
5. <u>Mimusops kauki</u> , Linn.	Leaf
6. <u>Rauwolfia serpentina</u> , Benth.	Root
7. <u>Holarrhena antidysenterica</u> , Roth A.DC Prodr.	Bark
8. <u>Calotropis gigantea</u> , R.Br.	Leaf

PLATE - I

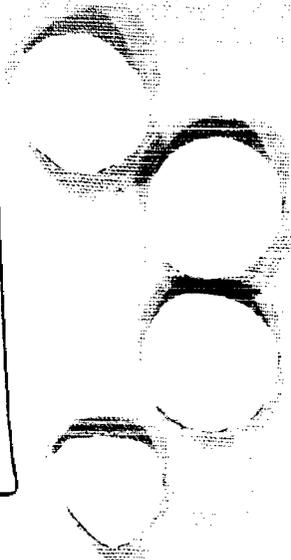
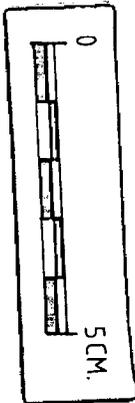
- A Roots of Viburnum foetidum, Wall
- B Roots of Hemidesmus indicus, R.Br.Schult
- C Seeds of Strychnos nux-vomica, Linn
- D Barks of Psychotria truncata, Wall



A



B



C

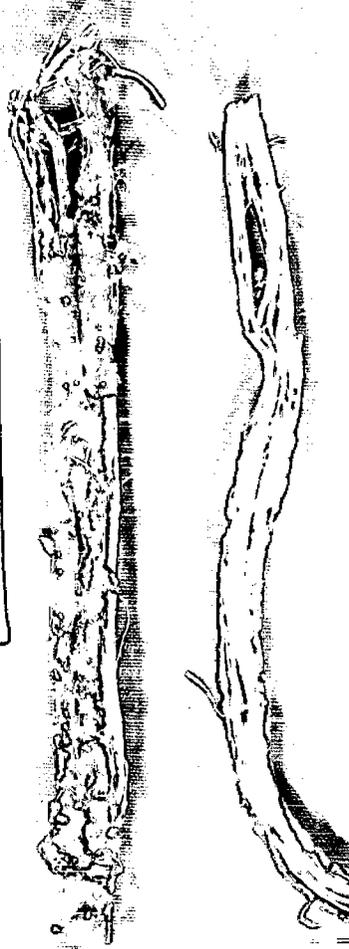
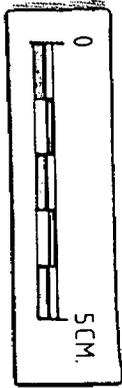


D

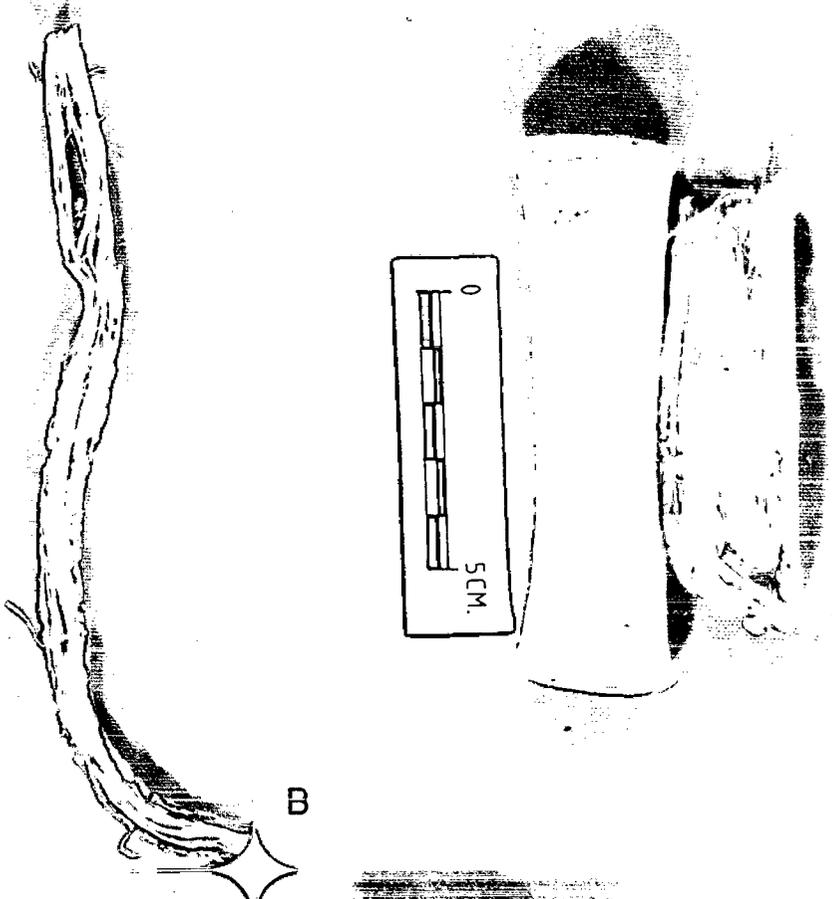
<u>Botanical name</u>	<u>Part/Parts studied</u>
9. <u>Hemidesmus indicus</u> , R.Br.Schult.	Root (Plate I-B)
10. <u>Strychnos nux-vomica</u> , Linn	Seed (Plate I-C)
11. <u>Ixora parviflora</u> , Vahl.	Root
12. <u>Oldenlandia corymbosa</u> , Linn.	Herb
13. <u>Psychotria truncata</u> , Wall	Bark (Plate I-D) Leaf
14. <u>Paederia foetida</u> , Linn	Root
15. <u>Croton oblongifolius</u> , Roxb.	Bark, Leaf & Root.
16. <u>Ricinus communis</u> , Linn	Bark, Seed & Leaf
17. <u>Averrhoa bilimbi</u> , Linn	Leaf.
18. <u>Annona squamosa</u> , Linn	Bark & Leaf
19. <sup>a</sup> <u>Polylthia fragrans</u> , Benth.	Bark
20. <u>Machilus macrantha</u> , Nees.	Bark
21. <u>Thespesia populnea</u> (Corr) Soland.	Leaf
22. <u>Abutilon indicum</u> , Linn. Sweet	Leaf
23. <u>Hibiscus rosa-sinensis</u> , Linn	Leaf
24. <u>Helicteres isora</u> , Linn	Bark (Plate II-A)
25. <u>Sterculia urens</u> , Roxb.	Bark (Plate II-B)
26. <u>Grewia microcos</u> , Linn	Bark, Leaf & Root
27. <u>Nyctanthes arbor-tristis</u> , Linn	Bark & Leaf
28. <u>Eugenia jambolana</u> , Lamk.	Leaf
29. <u>Eucalyptus globulus</u> , Labill.	Bark
30. <u>Careya arborea</u> , Roxb.	Bark
31. <u>Capparis zeylanica</u> , Linn	Root (Plate II-C)
32. <u>Moringa pterygosperma</u> , Gaertn.	Bark
33. <u>Hydnocarpus wightiana</u> , Blume	Seed & Bark
34. <u>Casearia esculenta</u> , Roxb.	Root (Plate II-D)
35. <u>Maesa indica</u> , Wall.	Root (Plate III-A)
36. <u>Zizyphus rugosa</u> , Lamk	Bark

PLATE - II

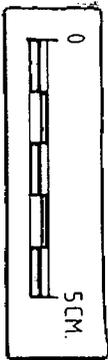
- A Barks of Helicteres isora, Linn
- B Barks of Sterculia urens, Roxb.
- C Roots of Capparis zeylanica, Linn.
- D Roots of Casearia esculenta, Roxb.



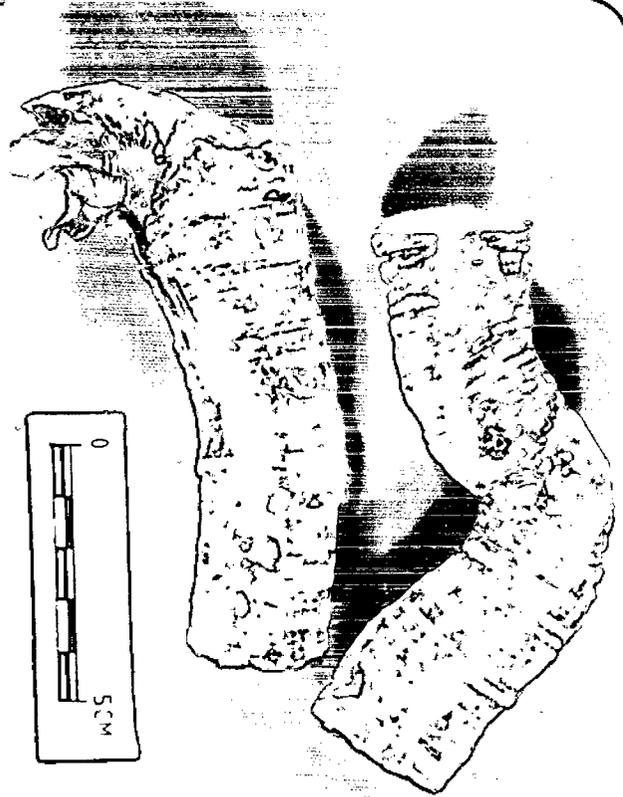
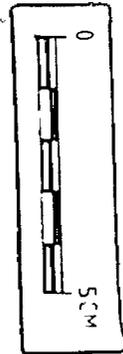
A



B



C



D

<u>Botanical name</u>	<u>Part/Parts studied</u>
37. <u>Zizyphus jujuba</u> , Lamk	Bark
38. <u>Stephania hernandifolia</u> , Wall. G	Root
39. <u>Tinospora cordifolia</u> , Miers.	Root & Leaf
40. <u>Cocculus macrocarpus</u> , W.A. Prodr.	Root
41. <u>Atylosia scarabaeoides</u> , Benth.	Herb
42. <u>Pterocarpus marsupium</u> , Roxb.	Root, Bark
43. <u>Tamarindus indica</u> , Linn	Bark and Leaf
44. <u>Cassia fistula</u> Linn.	Bark and Leaf
45. <u>Cassia tora</u> , Linn.	Seed
46. <u>Caesalpinia crista</u> , Linn	Root (Plate III-B)
47. <u>Mimosa pudica</u> , Linn	Leaf
48. <u>Glycosmis pentaphylla</u> , DC Prodr.	Root (Plate III-C)
49. <u>Citrus medica</u> , Linn	Root (Plate III-D)
50. <u>Zanthoxylum rhetsa</u> (Roxb) D.C.	Bark
51. <u>Murraya koenigii</u> , Spreng.	Leaf
52. <u>Cassia sophera</u> <u>rheedii</u> , Gmel.	Root
53. <u>Allophylus cobbe</u> , Blume	Bark
54. <u>Spondias pinnata</u> , Kurz.	Bark
55. <u>Adhatoda vasica</u> , Nees.	Root & Leaf.
56. <u>Andrographis paniculata</u> , Nees.	Herb
57. <u>Oroxylum indicum</u> , Vent.	Bark (Plate IV-A)
58. <u>Leucas aspera</u> , Spreng.	Root & Leaf
59. <u>Datura metel</u> , Linn	Leaf
60. <u>Lantana camara</u> , Linn	Leaf
61. <u>Vitex negundo</u> , Linn	Bark & Root
62. <u>Gmelina arborea</u> , Roxb.	Bark
63. <u>Ficus bengalensis</u> , Linn	Bark
64. <u>Arundinella gigantea</u> , Dalz.	Root (Plate IV-B)

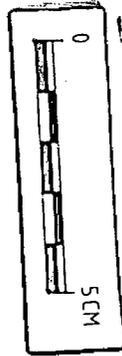
PLATE - III

A Roots of Maesa indica, Wall

B Roots of Caesalpinia crista, Linn.

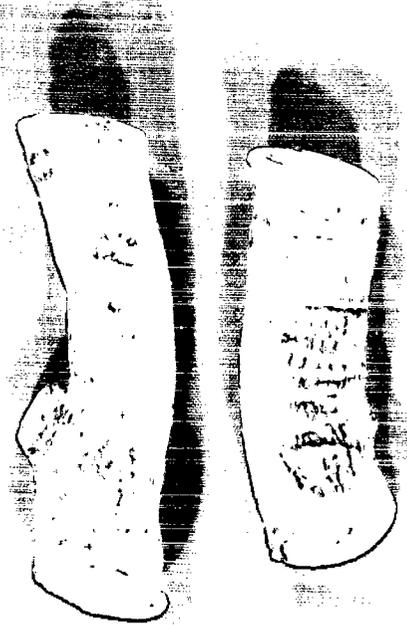
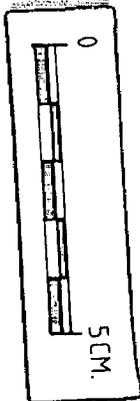
C Roots of Glycosmis pentaphylla, D.C.Prodr.

D Roots of Citrus medica, Linn



A

B



C

D

<u>Botanical name</u>	<u>Part/Parts studied</u>
65. <u>Cymbopogon citratus</u> , Star.	Leaf
66. <u>Asparagus racemosus</u> , Willd	Root
67. <u>Smilax macrophylla</u> , Romb.	Root
68. <u>Curcuma zedoaria</u> , Rose.	Rhizome
69. <u>Kaempferia rotunda</u> , Linn	Tuber (Plate IV-C)
70. <u>Lygodium flexuosum</u> (Linn) Swartz.	Root (Plate IV-D)

70 indigenous plant materials as mentioned above were identified by the Botany Department of Chowgule College, Margao-Goa and further identity was confirmed by Botanical survey of India, Western Zone, Pune. The herbarium sheets of these samples are kept in Pharmacognosy Research Laboratory, Goa College of Pharmacy, Panaji-Goa. The drugs consisted of different parts of plants such as bark, leaf, root, rhizome, frond and seed.

These drugs were cleaned, dried in oven at a temperature of 50 to 60°C and then powdered by means of a hammer mill. These powders were then sieved through sieve No.16 for obtaining the uniformity in the particle size of the drugs.

#### METHODS:

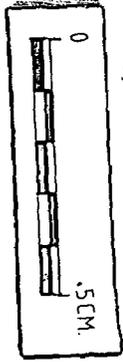
The plant materials have been used in indigenous system of medicine because of the pharmacological actions of chemical constituents present therein. Therefore, a preliminary screening of these plants was done in order to find out the presence or absence of different phytochemicals, such as alkaloids, anthraquinone glycosides, tannins, phenols and flavonoids, by means of chemical tests.

The following tests were performed:

1. Test for alkaloids: This was done as reported by Trease & Evans (1983). 0.5 gms of the plant material in moderately coarse powder was taken and to that was added 20 ml. of 1% of sulphuric acid and the whole mixture was boiled for 15 minutes. It was then filtered and the filtrate was made alkaline with 10% ammonia solution

PLATE - IV

- A Barks of Oroxylum indicum, Vent.
- B Roots of Arundinella gigantea, Dalz.
- C Tubers of Kaempferia rotunda, Linn.
- D Roots of Lygodium flexuosum, Linn.



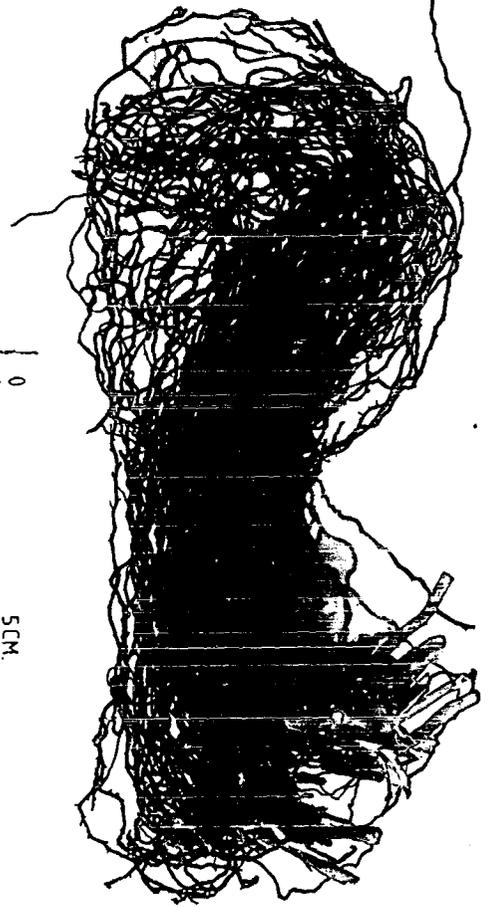
A



B



C



D

and extracted with 25 ml. of chloroform in a 100 cc separating funnel. The chloroform layer was separated and evaporated in a porcelain dish on hot water bath having a thermostat and regulating control. The residue thus obtained was dissolved in 1% sulphuric acid and the solution was divided into two parts.

(a) To one part was added Mayer's reagent. White precipitate indicated presence of alkaloid. (b) To second portion was added Dragendorff's reagent. Reddish brown precipitate indicated presence of alkaloid.

2. Test for anthraquinone glycoside: This test was performed as reported by Denston (1935). (c) 0.5 gms of the powdered plant material was boiled with 25ml. of 10% sulphuric acid for 10 minutes. It was then filtered and cooled. 5 ml. of filtrate was shaken with 5 ml. of benzene and set aside until the mixture was separated into two layers. The benzene layer was pipetted out and to that was added equal volume of 25% ammonia solution. Pink to reddish colour in ammoniacal layer indicated presence of anthraquinone glycosides.

Modified Test for anthraquinone glycosides: (d) The test was performed in a similar manner as above except that the powdered drug was boiled with 10 ml. of 10% ferric chloride and 20 ml. of 10% sulphuric acid. Pink or reddish colour in ammoniacal layer indicated presence of anthraquinone glycosides.

3. Test for tannins: This test was performed as reported by Prabhakar Rao et al (1985). (e) 5 gms. of the powder drug was extracted with 100 cc of 80% ethanol. This extract was next evaporated to dryness and the residue so obtained was dissolved in water. It was then filtered and to the filtrate was added equal volume of 1% solution of gelatin containing 10% sodium chloride. The precipitate indicated presence of tannins. (f) To 5 ml. of the aqueous extract of the drug as prepared above was added 0.5 gm of sodium acid phosphate and heated for 20 minutes. It was then filtered and to the filtrate was added equal volume of 2% solution of phenazone. The precipitate indicated presence of Tannins. This test was perfor-

med as reported by Trease & Evans (1983).

4. Test for phenols. This test was performed as reported by Paech & Tracey (1955). 0.5 gm of powdered drug was boiled with 50 ml. of methanol for 30 minutes. It was then filtered and to the filtrate was added equal volume of 1% aqueous solution of ferric chloride. Blue, green, violet or red colour indicated presence of phenols.

5. Test for flavonoids:

(i) Shinoda's test: This is as reported by Prabhakar Rao et al(1985) 10 grams of powder drug was extracted with 100 ml of 95% of ethanol by heating on hot water bath for half an hour. It was then filtered and to 1 ml. of filtrate was added few pieces of magnesium turnings and few drops of concentrated hydrochloric acid. Red or pink colour indicated presence of flavonoids.

Chromatography study:

Extraction Method for Chemotaxonomy:

10 gms. of powder drug was packed in thimble and placed in soxhlet extractor of 250 cc capacity and extracted in a hot controlled water bath with a thermostat using methanol till the siphoned extract was colourless, indicating completion of the extraction. This extract was then filtered and the filtrate was concentrated by distillation in a vacuo.

The procedure followed was that a piece of cotton wool was put in the mouth of siphon and a cloth bag containing 10 gms of powder drug was placed in extractor. Reservoir was fixed to the extractor and the whole assembly was placed in a thermostat controlled water bath. The assembly was fixed with the help of clamps. Methanol was poured from top upon the bag containing powder till it siphoned to reservoir. More solvent about 50 cc was poured on the drug

and a condenser was fixed on the top of the extractor and connected to the tap water by means of rubber tubings. Few pieces of porcelain were put in the reservoir to avoid bumping. The water bath was switched on and when methanol started dripping inside the extractor over the drug, the temperature was maintained at 60°C. The flow of the water from the condenser was also regulated. The extraction continued till it showed no more colour from powder and siphoned solvent was almost colourless. The extract was filtered. The filtrate was then concentrated by distillation in vacuo. This concentrated solution was used in chromatography study for Chemotaxonomy for spotting purpose.

#### TLC Chromatographic technique: (Thin Layer chromatography)

##### Setting out the Glass Plates:

The plates were carefully cleaned and completely freed of grease. The plates were thoroughly scrubbed with a scoring powder (e.g. Vim) and then cleaned with water. They were then placed in chromic-sulphuric acid solution for about 1 hour. They were then taken out and thoroughly brushed under running tap water rinsed, cleaned with distilled water and dried on a drying rack at room temperature. They were then rubbed dry with absorbent cotton.

Preparing the camag spreader: The Camag coating apparatus used was of the model for size of 20 cm. plates. A guide rail screwed onto the baseboard for even pushing of glass plates. The slurry reservoir was fixed to the baseboard and the adjustment of the layer thickness was made by slipping a metallic plate of adjusted thickness of 250  $\mu$  into the reservoir. Thus a rectangular reservoir was made ready for slurry of required thickness, below which a glass plate was placed.

Preparing the suspension (Silica Gel G) and filling the spreader: 50 gms. of silica gel G was mixed with 110 cc of distilled water by magnetic stirrer in

a 500 ml. beaker. The slurry was then immediately transferred to the Camag open reservoir. Each plate was then pushed smoothly forward by means of the succeeding plate. The process was interrupted when the front edge of the new plate had just passed below the automatic thickness adjuster.

#### Treatment of the Plates after coating

**Drying:** The plates were left in position until the surface became completely mat (about 20 minutes). The plates were then left overnight to dry in air.

**Activation:** The plates were placed in a drying rack and the assembly was placed in electric oven at  $105^{\circ}$  for 30 minutes after which the plates were taken out and to obtain a sharp boundary, about 2 mm of each edge of the layer was wiped off with the thumb.

**Applying the substance:** TLC plate was placed on camag square type plastic template so that the glass plate was firmly fixed in that template. A small rectangular plastic material with notches called cursor was moved to the bottom end of the template. The glass plate was then pushed up against the Cursor. The notches in the Cursor permitted the substance to be spotted directly onto the plate with the help of a micropipette of 10  $\mu$ l capacity. The starting point and the front line were marked at the edges of the plate. The starting point was exactly 2.5 cm from the edge of the plate. With the sharp micropipette a volume of 10  $\mu$ l was used twice to spot the extract of each plant material. Thus 10 spottings were done corresponding to 10 plant materials. The diameter of the starting spot was kept as small as possible by applying the solution twice in succession, allowing them to dry out for a short time between each application. Thus the plates were made ready for developing.

**Development of the plate:** Chromatographic rectangular tank of 20 x 20 cm plate was taken. Its height was 35 cms, breadth 15 cms and length 30 cms. It was cleaned with distilled water and then dried. The walls of the tank was cov-

ered with filter paper. The required developing solvent (200 cc) was put into the tank to a depth of about 1 cm. with the solvent, which was then shaken thoroughly to soak the filter paper completely. Two hours were allowed to elapse before inserting the plates. The plates were then placed in the tank in slanting condition. 4 plates were placed in the tank at a time and the care was taken to see that the lower edges were not too close together, otherwise mobile phase could rise between the plates by capillary action. It was then closed with ground-on lid. Chromatogram was allowed to run for a distance of 10 cm. finishing line marked before hand. The plates were then carefully removed from the tank as soon as the finishing line was reached. The lid was opened and the plates were taken out and dried by air first and then in a drying cabinet at a temperature of 45°C.

#### Visualisation of the Spots:

The Chromoplates were then seen for any spot colour or fluorescence under UV lamp (emission maxima 254 and 365 nm) for identifying fluorescent compound in long wave UV light. Further the different spots were observed by keeping the plate in an iodine chamber and it was found that the spot containing organic compound turned yellow or yellowish brown. The plates were also sprayed with different spray reagents described under the chapter on spray-reagents for the identification of the presence of plant phenol derivatives. The spots so observed under above conditions were noted for the Rf values and the colours.

#### Solvent systems used in TLC:

The developing solvents used for plant phenol derivatives in case of thin layer chromatography (TLC) were as follows:

These solvents have been reported by Stahl (1969). The table 2 gives the composition of the solvent system and compound classes for which they were used.

T A B L E - 2SOLVENT SYSTEMS USED IN THIN LAYER CHROMATOGRAPHY

No.	Solvent composition	Compound
I.	Benzene + Chloroform (50+50)	Lichen constituents.
II.	Benzene + acetone (90+10)	Coumarins, polyphenol acetates, lignans methyl ethers.
III.	Chloroform + methanol (97+3)	Coumarins & its precursors.
IV.	Benzene + ethyl formate + formic acid (75+24+1)	Anthraquinones derivatives.
V.	Toluene + ethyl formate + formic acid (50+40+10)	Phenols, flavone aglycones, phenol carboxylic acids, hydroxy coumarine.
VI.	Toluene + Chloroform + acetone (40+25+35)	Compound classes as in V.
VII.	Ethyl acetate + butanone + formic acid + water (50+30+10+10)	Glycosides, anthocyanins.
VIII.	N. Butanol + N-propanol + 2N ammonium hydroxide (10+60+30)	Hydroxyquinones.

Spray - Reagents

The different spray reagents used for phenolic plant constituents as chemotaxonomic markers were the following:

(1) Aluminium chloride ( $AlCl_3$ )

1% aluminium chloride solution in methanol yielded fluorescence/colour in the long wave UV light.

(2) Anisaldehyde - sulphuric acid:

1 ml. of concentrated sulphuric acid was added to a solution of 0.5 ml. anisaldehyde in 50 ml. acetic acid. This plate was sprayed with this reagent and heated to  $105^{\circ}$  for maximum colour intensity of the spots. Lichen constituents and phenols yielded violet or blue colours.

(3) Antimony trichloride ( $\text{AnIIIcl}_3$ ):

10% solution of antimony trichloride in chloroform yielded spots which fluorescence with different colours in long wave UV light.

(4) Ferric chloride ( $\text{Fecl}_3$ ):

5% solution of ferric chloride in 0.5 ml. hydrochloric acid gave blue or greenish colour for phenols and red colour for hydroxamic acid.

(5) Folin ciocalteu reagent:

The plate was first sprayed with 20% aqueous sodium carbonate solution, dried and then sprayed with folin ciocalteu reagent which was diluted with 3 times its volume of water. It gave blue or grey colour.

(6) Iodine:

The chromatogram was introduced into a closed vessel on the floor of which some crystals of iodine were placed. Many organic compounds yielded brown spots.

(7) Lead acetate:

25% aqueous solution of basic lead acetate yielded fluorescence in long wave UV light.

(8) Potassium hydroxide:

5% methanolic potassium hydroxide solution gave characteristic colours in long wave UV light.

Chromatographic (TLC) study of methanolic extract using ethyl acetate + formic acid + water in the proportion of 8:1:1 for flavonoids.

The plates were prepared and spotted with drug sample solutions as described under TLC chromatographic technique. They were run in a developing solvent of ethyl acetate, formic acid and water (8:1:1) for a run of 10 cm. They were then taken out, dried and sprayed with a mixture of 3% aqueous boric acid and 10% aqueous oxalic acid solution. The spray mixture was prepared in the proportion of 30 ml. of boric acid and 10 ml. of oxalic acid. Taubock (1942) has described this method. The plates were heated at 105°C until the spots attained maximum fluorescence of yellowish green in colour. All the coloured spots were marked and their Rf values were noted for finger print technique.

Paper Chromatography

Two dimensional paper chromatographic study

The method developed was according to Mabry *et al* (1970) with slight modification. Instead of (46 x 57 cm) size paper, 11" x 11" paper was used. The paper was Whatman No.1 Chromatographic paper and the method was ascending type. The solution obtained under extraction method was spotted on the lower right hand corner of a sheet of paper by repeated application. A hair dryer was used for solvent evaporation, between repeated applications of the solution on the paper. The final spot was about 1 cm in diameter and about 2.5 cm from the edges of the paper. The chromatogram was developed in ascending manner in a chromatocab using TBA as solvent for first run. This TBA solvent consisted of tertiary butanol + glacial acetic acid + water in the proportion of 3:1:1. When the solvent front reached to the mark on the top of the paper about 22 cm., the paper was removed, dried and again run in 15% acetic acid for second run for two dimension technique. The side of the paper dipped in HOAC solvent was the one parallel to the run of the previous solvent run. HOAC system was made up of 15 ml. of glacial acetic acid mixed with 85 ml. of water. TBA & HOAC

systems are satisfactory for the two dimensional paper chromatographic analysis of most flavonoids extracts as reported by Marbry (1970). The dried two dimensionally developed chromatogram was viewed in UV light along and in the presence of ammonia fumes. (The mouth of 100 ml. wide mouth bottle containing concentrated ammonium hydroxide was held in contact with each spot for about 10 seconds\*) All spots which were detected by this procedure were circled with a lead pencil and their colours were noted. Then the paper was marked on the boundaries of all four sides with the lead pencil and then TBA run was marked as Y axis and HOAC was marked X axis. Both the axis were subdivided into 9 equal divisions. Along X axis it was marked as 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, and on Y axis marked as A, B, C, D, E, F, G, H, I. The spots were then marked as finger prints by the symbols of alphabets and numbers according to their locations within X and Y axis.

#### Microscopical study of the powdered drugs

About 0.5 gms. of the powdered drug was taken in 100 cc beaker and to that was added 50 cc of strong solution of chloral hydrate (5 parts of chloral hydrate for 2 parts of water) and boiled for half an hour. This solution was added as a clearing reagent to clear of colouring matters. It dissolves starch, proteins, chlorophyll, resins, volatile oils and causes shrunken cells to expand. But it does not dissolve calcium oxalate crystals and is therefore a good reagent for the detection of the crystals.

The powder cleared with chloral hydrate was placed on a slide and mounted in the chloral hydrate solution to examine trichomes, calcium oxalate crystals, stomata, epidermal cells and other nonlignified cells. Six slides of each powder were made and observed under microscope.

For examination of lignified structures like vessels, fibres, stone cells, the powder was placed on a watch glass and soaked with alcoholic solution of phloroglucinol for about 5 minutes and then excess of phloroglucinol was

removed by filter paper. The powder thus treated was taken on a slide and 2 or 3 drops of concentrated hydrochloric acid was added and covered with cover slip and examined under microscope. Such six slides were prepared and observed under microscope.

Thirdly to examine starch grains powder which was not boiled with chloral hydrate was taken on a slide and mounted in iodine solution for staining starch grains and examined under microscope. Three slides of this type for each powder were examined under microscope.

For leaf powder, microscopic diagnostic characters such as calcium oxalate crystals, trichomes, stomata, epidermal cells, xylem vessels and fibres were observed.

For root and rhizome powder, characters such as calcium oxalate crystals, starch grains, fibres, vessels, stone cells were observed.

For seed powder, trichomes, endosperm cells, aleurone grains, pigment cells and stone cells were observed.

For herb powder, trichomes, calcium oxalate crystals, starch grains, vessels, fibres were observed.

All the above diagnostic microscopical characters were measured in microns and the drawings of each character was made on a paper with the help of camera lucida.

The measurements of the cells were done by the use of eye piece micrometer which was calibrated in microns by using stage micrometer. The stage micrometer, is a glass slide 3 x 1" with a scale of 1 mm. long engraved on the

centre of it. Its line is divided into 100 divisions. The eye piece micrometer is a small disc which can be inserted into the eye piece lense. On this micrometer is engraved a line of 1 cm divided into 100 divisions of 1 mm and 0.01 mm parts.

#### Calibration of Eye piece micrometer:

The upper lense of the eye piece was unscrewed and the eye piece micrometer was placed on the ridge inside and the lense was replaced. Then the stage micrometer was placed on the stage and focused as usual so that the divisions of eye piece micrometer were seen together with divisions of stage micrometer. Some divisions of stage micrometer were allowed to coincide with 0 of eye piece micrometer or any division of eye piece. The coinciding lines of both micrometers were considered as 0 and then it was seen for further coincidence of the division of the stage, with the division of eye piece micrometer. 100 divisions of stage correspond to 1000 microns or 1 division of stage corresponds to 10 microns. If X division of stage coincide with Y division of eye piece micrometer, one division of eye piece corresponding to division of stage was calculated. ( $\frac{X}{Y}$  division of stage correspond to 1 division of eye piece micrometer.)

Now 1 division of stage corresponds to 10 microns. Therefore,  $X/Y$  division of stage corresponding to how many microns was calculated. This value gave the value in microns for 1 division of eye piece micrometer. Thus such values were found out for each magnification.

For the purpose of drawing the characters on the paper, prism type camera lucida was used which was fitted over the eye piece of the microscope. In principle, when in use light from the object passes directly to the observer's eye through an opening in the silvered surface of the left hand prism. At the same time, light from the drawing paper and pencil is reflected by the

right hand prism and by the silvered surface. So that the pencil appears superimposed on the object which may thus be traced.

Each prepared slide was placed on the stage of the microscope and the diagnostic characters seen inside were measured in terms of divisions of eye piece micrometer which was placed inside the eye lense and further the drawings of this structures were made with the help of camera lucida, on the paper pinned to drawing board. The eye lense and the objective used for the purpose were noted to multiply the divisions of the eye piece micrometer by the calibration factor. The mean values in terms of microns were calculated from the measurements made. The drawings of diagnostic characters of powder herbal samples are maintained in Pharmacognosy Research Laboratory of Goa College of Pharmacy, Panaji - Goa.

CHAPTER III  
MORPHOLOGY AND TAXONOMY OF THE  
MEDICINAL PLANTS

CHAPTER IIIMORPHOLOGY AND TAXONOMY OF THE MEDICINAL PLANTS

This chapter deals with the major morphological characters of the medicinal plants along with their taxonomic positions in the plant Kingdom. Each plant has been described in the order of Class, Sub-class, Order, Family, Botanical name, Vernacular Name, Habitat, Habit, Distribution of plants in Goa, Morphology and Uses. The object of taxonomy is to describe, name and classify plants in such a manner that their relationship with regard to their descent from a common ancestry may be brought out. The ultimate object of classification was to arrange plants in such a way as to give an idea about their phylogenetic relationship. The phylum angiosperm is divided into monocotyledons and dicotyledons. Unlike monocotyledons which typically have their floral parts in threes, dicotyledons flowers are usually pentamerous or tetramerous. The classification adopted in this chapter was based on Engler's system of classification. In this system dicotyledoneae is divided into two sub-classes (1) Archichlamydeae, representing the lower dicotyledons and (2) Sympetalae, representing the higher dicotyledons. Those flowers with no perianth or with only one whorl or with polypetalous corolla form sub-class Archichlamydeae while gamopetalous condition with one or two whorls of perianth comes under the sub-class Sympetalae. The names of the orders terminate in - ales and families usually in - aceae. The drugs thus collected have been described in the following manner.

1. Class : Dicotyledoneae  
Sub-Class : Archichlamydeae  
Order : Centrospermales  
Family : Nyctaginaceae  
Botanical  
Name : Boerhaavia diffusa, Linn.  
Vernacular  
Name : Punarnava  
Habitat : Grows well where there is plenty of wind. It requires limy soil and grows on waste ground.  
Habit : A diffuse prostrate herb.  
Distribu-  
tion : All over Goa on road side.  
Morphology: Leaves cordate-ovate, entire, opposite, edges waved, tinged with red; flowers small pink, sessile on the apex of the pedicels from the axils and ends of branches; fruit oblong, dull green, longitudinally five-grooved, studded all over with glandular hairs; flowering in April.  
Uses : Leaves used as diuretic and in cold. Roots used in gonorrhoea.
2. Class : Dicotyledoneae  
Sub-Class : Archichlamydeae  
Order : Curcubitales  
Family : Cucurbitaceae  
Botanical  
Name : Momordica dioica, Roxb.  
Vernacular  
Name : Faglin  
Habitat : Grows in rainy season in rocky soil.  
Habit : Tendril climbers dioecious, perennial herb with tuberous roots.  
Distribu-  
tion : Sattari - Morlem, Paryem, Codal, Nanacha Dongar; Sanguem: Viliyan forests, Molem, Netravali; Canacona : Loliem.

Morphology: Stems slender, branched, furrowed, glabrous and shining.

Tendrils simple, elongate, striate, glabrous; leaves membranous, broadly ovate, glabrous, minutely punctate, entire, 3 - 5 lobed, lobes triangular, distinctly denticulate; male flowers, peduncle solitary, 1 - flowered, slender, angled, usually pubescent near the top, otherwise glabrous, bract cucullate, inserted a little below the flower and enclosing it, orbicular-reniform, usually pubescent on both sides, strongly nerved, calyx-lobes distant, linear lanceolate, corolla-yellow, oblong lanceolate; female flowers : Peduncles nearly as long as those of male usually with a small bract near the base, ovary clothed with long soft papillae; fruit - ellipsoid, shortly beaked, densely echinate with soft spines; seeds - many, broadly ellipsoid, slightly compressed, slightly and irregularly corrugated enclosed in a red pulp. Flowering in June - August.

Uses : Roots used in piles and certain bowel affections connected with such complaints. The juice of the root is a domestic remedy for inflammation caused by the contact with the urine of house lizard.

3. Class : Dicotyledoneae

Sub-Class : Sympetalae

Order : Dipsacales

Family : Caprifoliaceae

Botanical Name : Viburnum foetidum, Wall.

Vernacular Name : Narval

Habitat : Grows well in a place saturated with decayed vegetable matter, specially in sandy clay soil.

Habit : An erect shrub, 6 to 10 ft. high.

Distribution : Sattari: Morlem, Paryem; Ilhas: Corlim; Sanvordem.

Morphology: Branchlets stellate, hairy; leaves scarcely acuminate, serrated, base rounded, axils of primary nerves with tuft of hairs; corymbs terminal,

4 - 8 rayed, peduncled, calyx - teeth minute, triangular, corolla - white lobes round, drupes compressed, sub-acute, red; seeds, dorsally 2 - grooved, ventrally 3 - grooved. All parts of plant have a powerful unpleasant odour. Flowering in June - July.

Uses : Roots used in menorrhagia and as antipyretic. Extract of roots is given to women after delivery to reduce giddiness.

4. Class : Dicotyledoneae

Sub-Class : Sympetalae

Order : Ebenales

Family : Sapotaceae

Botanical Name : Mimusops elengi, Linn.

Vernacular Name : Onval

Habitat : Grows in all types of soil.

Habit : A large, glabrous evergreen tree, 40 - 60 ft. high with a compact leafy head and short erect trunk.

Morphology: Leaves elliptic, glabrous; flowers star-shaped, white, fragrant, calyx fulvous-pubescent, segments 8, 4-outer ovate-lanceolate, 4-inner narrower than outer, corolla one-petalled, longer than calyx, tube very short, fleshy border composed of a double series of segments the exterior one consists of 16 spreading, the interior one of 8, generally contorted and converging, all are lanceolate, a little torn at their extremities, nectary eight-leaved, conical, ragged, hairy at the base, inserted alternately with the filaments into the mouth of the tube. Flowering in January - February.

(Plate V-A).

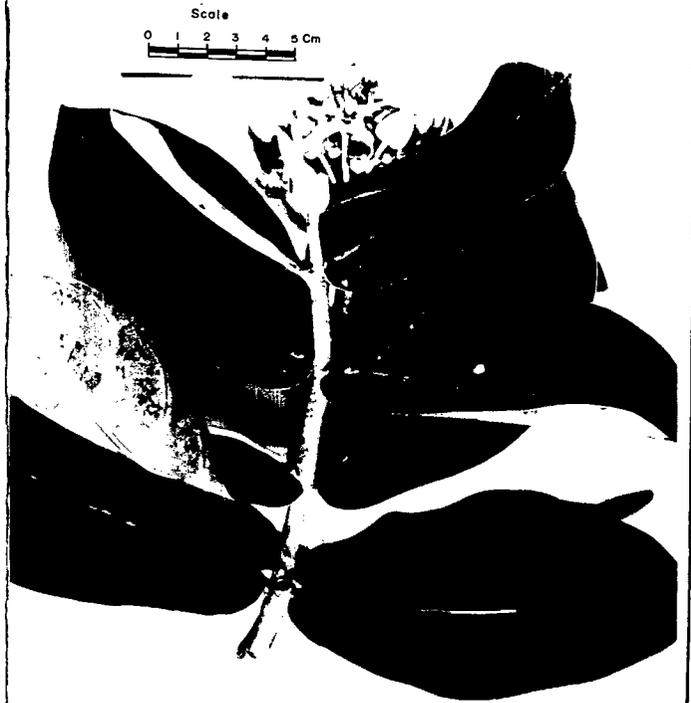
Uses : Infusion of bark is useful as a gargle in salivation, in diseases of gums and teeth and to strengthen them. Also used in discharges from the mucous membrane of bladder and urethra. It increases fertility in

women.

5. Class : Dicotyledoneae  
Sub-Class : Sympetalae  
Order : Ebenales  
Family : Sapotaceae  
 Botanical  
Name : Mimusops kauki, Linn.  
 Vernacular  
Name : Adam  
Habitat : Cultivated in gardens and grows in all types of soil.  
Habit : A small tree below 5 metres.  
Distribu-  
tion : All places of Goa.  
Morphology: Leaves obovate coriaceous; stems straight; flowers axillary, calyx-segments 6 - 8 in 2 series, corolla tube short, broad, with exterior & interior lobes, stamens 6 attached at the base of the corolla and opposite the lobes of its interior series, filaments short, anthers lanceolate; berry globose, epicarp crustaceous; seeds few, obliquely ovate, testa hard, shining. Flowering in November - December.  
Uses : Leaves used as antiinflammatory. Seeds used as antipyretic.
6. Class : Dicotyledoneae  
Sub-Class : Sympetalae  
Order : Gentianales  
Family : Apocynaceae  
 Botanical  
Name : Rauwolfia serpentina, Benth.  
 Vernacular  
Name : Adaki  
Habitat : It requires only rain water and rocky soil, usually found where bamboos are grown.



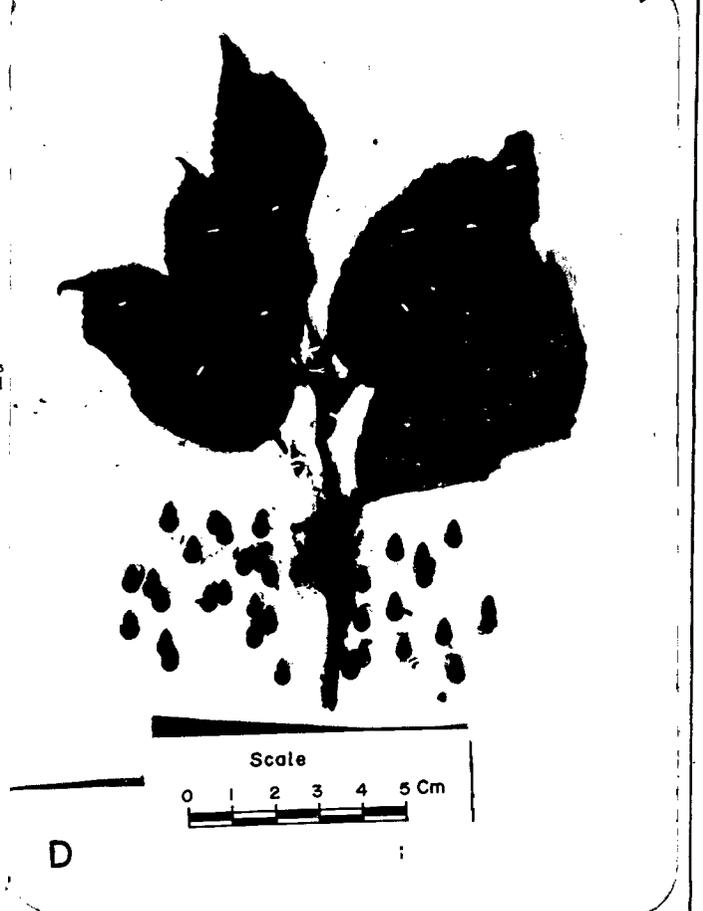
A



B



C



D

PLATE - V

A Mimusops elengi, Linn

B Calotropis gigantea, R.Br.

C Hibiscus rosa-sinensis, Linn.

D Maesa indica, Wall

Habit : A small erect shrub.

Distribution : Sattari : Valpoi-Nagram, Thanem, Wadicha Dongar, Caranzol; Sanguem: Sidh forest, Cubari, Bati, Rumde, Molem; Quepem: Rivani, Kusman, Budsari; Canacona - Amdiga near Bhutpal, Bhutpal forest, Ordofond, Maxem.

Morphology: Leaves in whorls of three thin lanceolate, glabrous, bright green above, pale beneath; flowers white, often tinged with red colour, inflorescence corumbos-cyme, pedicels bright red, bracts beneath pedicels, calyx glabrous, bright red, corolla white, a tube slender, swollen a little above the middle; drupes purplish black when ripe. Flowering in March-June.

Uses : Roots used in high blood pressure, insomnia, insanity and as an antidote for bites of poisonous reptiles.

7. Class : Dicotyledoneae

Sub-Class : Sympetalae

Order : Gentianales

Family : Apocynaceae

Botanical Name : Holarrhena antidysenterica, Roth A.DC Prodr.

Vernacular Name : Kudo

Habitat : Grows in rocky soil.

Habit : A small tree.

Distribution : Sattari: Hariali forests, near Nandore, Maloli forest, Wadicha Dongar, Koparde, Codal, Morlem; Ponda; Sanguem: Batti, Dudol, Nandrona near Molem, Bavanbunda; Quepem: Budasari - Conndugarha; Canacona: Ordofond, Tidal.

Morphology: Leaves broadly ovate to elliptic, obtuse, glabrous; flowers white, inodorous, in terminal corymbos cymes, calyx oblong-lanceolate, acute, ciliate, corolla puberulous outside, slightly inflated near base over the stamens, throat hairy inside; follicles cylindrical, often dotted with white spots; seeds linear, oblong, tipped with a spreading deciduous coma of brown

hairs. Flowering February - June.

Uses : Bark used for dysentery, rheumatism and bowel affections.

8. Class : Dicotyledoneae

Sub-Class : Sympetalae

Order : Gentianales

Family : Asclepiadaceae

Botanical Name : Calotropis gigantea, R.Br.

Vernacular Name : Rui

Habitat : Grows in sandy as well as red soil.

Habit : Tall shrub, reaching 8 - 10 ft. high.

Distribution : Panaji: coastal area; Sanguem: Barazan mine area, Netravali, Chichigal; Quepem: Budsari - Goundugarha, Canacona : Ordofo - Tudal Road. Common on waste land and road side.

Morphology: Leaves sessile, elliptic, oblong, acute, thick, glaucous, green, clothed beneath and more or less above with cottony tomentum; flowers innumeros, purplish in umbels lateral cymes, calyx divided to the base, sepals ovate, corolla deltoid-ovate, subacute, revolute, follicles ovate, flattened, narrowly margined, minutely tomentose, brown in colour, flowering in February - July. (Plate V-B).

Uses : Tincture of leaves used in fever. Bark used as antiseptic & for various diseases of lungs. Leaves are warmed with castor oil and applied on inflamed parts. Leaves are tied on children's stomach to pass motion.

9. Class : Dicotyledoneae

Sub-Class : Sympetalae

Order : Gentianales

Family : Asclepiadaceae

Botanical Name : Hemidesmus indicus, R.Br.Schult.  
Vernacular Name : Uparsal  
Habitat : Grows in rocky soil.  
Habit : A perennial prostrate shrub.  
Distribution : Bardez: Pilern; Ilhas: Corlim; Sattari: Morlem, Valpoi.  
Morphology: Leaves linear lanceolate, apiculate; flowers yellow, crowded in subsessile cymes in the opposite axils, pedicels short, clothed with numerous ovate acute imbricating bracts, calyx glabrous outside, lobes ovate, acute with membranous ciliolate margins, corolla greenish outside, purplish inside, tubes very short, lobes valvate, fleshy, ovate-oblong; follicles cylindrical, tapering to a point at apex, slightly curved, striate, glabrous; seeds ovate-oblong, flattened black; flowering in September - December.  
Uses : Roots are used for kidney and urinary troubles, in anaemia & as blood purifier.

10. Class : Dicotyledoneae  
Sub-Class : Sympetalae  
Order : Gentianales  
Family : Loganiaceae  
Botanical Name : Strychnos nux-vomica, Linn.  
Vernacular Name : Kazro  
Habitat : Grows in rocky soil.  
Habit : Deciduous tree reaching to 100 ft. in height.  
Distribution : Sattari: Valpoi, Nagaram, Deosali (Caranzol), near Pale Village, Codal, Codal-Nanora Road; Bardez: Porvorim; Salcete: Uerna; Sanguem: Sidh forest near Bhati; Molem; Canacona : Ordofond-Jhani Jawal, Ordofond

Tudal.

Morphology: Leaves broadly elliptic, acute, obtuse, glabrous shining; flowers numerous, greenish white in terminal pedunculate pubescent compound cymes, calyx pubescent outside, corolla, 5-lobed, glabrous, tube cylindrical, hairy inside, throat glabrous; fruit globose, slightly rough but shining, orange-red when ripe. Seeds many discoid, much compressed, concave on one side and convex on other, clothed on both sides with hairs. Flowering in May - April.

Uses : Seeds are used as bitter tonics, in nervous disorders & for stomach-ache.

11. Class : Dicotyledoneae  
Sub-Class : Sympetalae  
Order : Gentianales  
Family : Rubiaceae
- Botanical Name : Ixora parviflora, Vahl.  
Vernacular Name : Dhavi Pitkoli.  
Habitat : Grows in rocky as well as red soil.  
Habit : A small, much branched evergreen shrub.  
Distribution : Sattari: Nandore, bank of Mahadevi River, Nanacha Dongar, Codal, Sanguem: Balli; Quipem; Canacona: Maxem.
- Morphology: Leaves coriaceous, oblong; flowers white, small, slightly odorous and numerous in subglobose clusters in cymes; fruit didymous, flowering in November - March.  
Uses : Roots are used in white discharge in women.

12. Class : Dicotyledoneae  
Sub-Class : Sympetalae

Order : Gentianales

Family : Rubiaceae

Botanical Name : Oldenlandia corymbosa, Linn.

Vernacular Name : Paripat

Habitat : Grows in rocky soil. Usually found where Eleusine coracana (Nashni) is cultivated.

Habit : An annual slender herb.

Distribution : Sanguelim; Sattari; Nandore, bank of Mahadevi River, Nanacha Dongar, Codal, Ilhas; Rice fields near Santa Cruz Village; Sanguem; Balli; Canacona; Bhutpal.

Morphology: Leaves subsessile, linear-lanceolate, acute; flowers on filiform pedicels longer than calyx, usually 2 to 3 on the top of very slender axillary solitary peduncle, calyx teeth subulate, shorter than corolla tube, corolla white, lobes acute; capsules globose, glabrous; seeds pale brown angular. Flowering in September - November.

Uses : Herb is used in fever and liver troubles.

13. Class : Dicotyledoneae

Sub-Class : Sympetalae

Order : Gentianales

Family : Rubiaceae

Botanical Name : Psychotria truncata, Wall.

Vernacular name : Sawo Kanal

Habitat : Grows in rocky soil.

Habit : Stout, erect glabrous shrub.

Distribution : Sattari; Morlem, Pareyem, Codal, Valpoi; Sanguem; Netravali;

Canacona: Mazem.

**Morphology :** Leaves green above, pale beneath, obovate, shortly and abruptly acuminate, margins slightly recurved; flowers sessile, in dense terminal cymes, calyx broadly campanulate, truncate, corolla waxy white, glabrous; fruit ellipsoid, smooth crowned by the truncate calyx, pyrenes without furrows, planoconvex; seeds planoconvex. Flowering in April - May.

**Uses :** Extract of the bark is used in cold.

**14. Class :** Dicotyledoneae

**Sub-Class :** Sympetalae

**Order :** Gentianales

**Family :** Rubiaceae

**Botanical Name :** Paederia foetida, Linn

**Vernacular Name :** Modshi

**Habitat :** Grows in all types of soil.

**Habit :** A slender climbing shrub.

**Distribution :** Sattari: Morlem, Paryem, Valpoi; Ilhas : Corlim, Bardez:

Pilerne.

**Morphology :** Leaves oblong ovate and long petioled, stipules broad cordate; flowers purple, tubular funnel-shaped in axillary and terminal cymose; berry dry, compressed, oblong, red, smooth, with fine lines on each side, one-celled, two-seeded; seed compressed, smooth with a membranous wing all round. Flowering in August - September.

**Uses :** Roots used in diarrhoea, as emetic and for externally for body pain.

**15. Class :** Dicotyledoneae

**Sub-Class :** Archichlamydeae

Order : Geraniales  
Family : Euphorbiaceae  
 Botanical  
Name : Croton oblongifolius, Roxb.  
Vernacular  
Name : Ghanasurang  
Habitat : Grows in rocky as well as red soil.  
Habit : A middle size tree.  
Distribu-  
tion : Sattari: Morlem, Paryem; Bicholim: Kudchirem, Canacona: Maxem.  
Morphology : Leaves crowded towards the end of branchlets, oblong lanceolate, subacute, glabrous, crenate or serrate, very smooth on both sides, petioles round and smooth, with a lateral gland on each side of their spines; stipules small, caducous; flowers pale, yellowish green, solitary in the axils of minute bracts on long erect often fascicled racemes, the male in the upper part of raceme, females are on lower part; capsules subglobose, slightly 3-lobed, clothed with small orbicular scales; seeds ellipsoid, rounded. flowering in April - May.  
Uses : Roots used as anti-inflammatory. Leaves used as anti-pyretic. Bark used in reducing chronic enlargement of liver.

18. Class : Dicotyledonsae  
Sub-Class : Archichlamydeae  
Order : Geraniales  
Family : Euphorbiaceae  
 Botanical  
Name : Ricinus communis, Linn.  
Vernaocular  
Name : Erand  
Habitat : Grows in all types of soil, specially in areas of decayed vegetation.  
Habit : An evergreen small tree.

Distribu- :  
tion : All places of Goa.

Morphology: Leaves membranous, lobes from oblong to linear, acute or acuminate, serrated, petiole present; flowers large in terminal subpanicked racemes, monoecious, apetalous, upper male, lower female, male flowers, calyx membranous, stamens many; female flowers calyx spathaceous, caducous, ovary 3-celled, styles short, often highly coloured; capsule, globosely oblong, smooth or echinate; seeds oblong, smooth mottled. Flowering in December - January.

Uses : Roots used as purgative, anti-rheumatic and anti-inflammatory. The leaves are applied to the breast to stop the secretion of milk and leaves boiled with the root in goat's milk and water used as a local application in ophthalmia. Seeds used as purgative.

17. Class : Dicotyledoneae

Sub-Class : Archichlamydeae

Order : Geraniales

Family : Oxalidaceae

Botanical Name : Averrhoa bilimbi, Linn.

Vernacular Name : Bimblim

Habitat : Cultivated in gardens. Grows in all types of soil.

Habit : A small tree, 15 to 20 ft. high.

Distribu-  
tion : All places of Goa.

Morphology: Leaf imparipinnate; leaflets 11 - 35 crowded at the ends of branches, entire, pubescent on both surfaces, base round; flowers arising from the trunk and branches in short softly hairy panicles; sepals ovate-lanceolate, acute, pubescent, petal oblong spathulate; fruit oblong, obtusely lobed; seeds, exarillate. Flowering in October.

Uses : Used as astringent.

18. Class : Dicotyledoneae

Sub-Class : Archichlamydeae

Order : Magnoliales

Family : Annonaceae

Botanical  
Name : Annona squamosa, Linn.

Vernacular  
Name : Ater

Habitat : Cultivated in gardens; grows in all types of soil.

Habit : A small tree, about 20 ft. high.

Distribu-  
tion : All places of Goa.

Morphology: Leaves oblong-lanceolate, obtuse, glabrous above, glaucous and pubescent beneath; flowers solitary, sepals minute, triangular pubescent, petals pubescent on both surfaces; fruit globose, usually with a glaucous bloom on the surface when young, yellowish green when ripe, easily broken into large pieces; seeds brownish black, smooth with two lateral ridges, tapering towards the umbilical end, where there is a prominent ring, flowering in September - October.

Uses : Leaves crushed and applied to hair to kill hair bugs. The crushed leaves are applied to the nostrils of women suffering from hysterical or fainting fits. Bark is used as astringent.

19. Class : Dicotyledoneae

Sub-Class : Archichlamydeae

Order : Magnoliales

Family : Annonaceae

Botanical  
Name : Polyalthia fragrans, Benth.

## Vernacular

Name : Miryo

Habitat : Grows in rocky soil.

Habit : Middle size tree.

## Distribu-

tion : Sattari: Morlem, Paryem, Codal, Valpoi; Sanguem: Sidh forests, Molem, Colem; Canacona: Butpal forests.

Morphology: Leaves membranous; elliptic, acute, upper surface glabrous, shining, lower surface subglabrous; flowers in short peduncled, tomentose cyme from tubercles on the branches, pericarp brittle; seeds orbicular-ovoid. Flowering in April - June.

Uses : Bark is used as an antiinflammatory and for body pain. The powder of the bark is moistened with caju liquor and applied on body to relieve pain.

20. Class : Dicotyledoneae

Sub-Class : Sympetalae

Order : Gentianales

Family : Lauraceae

## Botanical

Name : Machilus macrantha, Nees.

## Vernacular

Name : Olom

Habitat : Grows in rocky soil.

Habit : A large tree.

## Distribu-

tion : Sanguem: Molem, Colem; Sattari: Morlem, Paryem; Canacona: Bhutpal forest.

Morphology: Leaves coriaceous, variable in shape, from oblong and rounded at both ends to elliptical lanceolate and acute at both ends, glabrous, shining above, glaucous beneath, finely reticulately veined; main nerves 8 - 12 pairs, not conspicuous, petioles long; flowers yellow, numerous, in penicles, near the

ends of branches, perianth, silky pubescent inside and outside, tube very short, segments oblong, subacute, filaments hairy; fruit smooth, dark-green dotted with white, ultimately becoming black. Flowering in December - March.

Uses : Bark used in rheumatism and in asthma.

21. Class : Dicotyledoneae

Sub-Class: Archichlamydeae

Order : Malvales

Family : Malvaceae

Botanical

Name : Thespesia populnea (Corr.) Soland.

Vernacular

Name : Bhendi

Habitat : Grows in red and clay soil, specially found in areas of decayed vegetation.

Habit : Small tree reaching 30 to 40 ft.

Distribu-

tion : Grown along the road side, in garden and waste lands.

Morphology: Leaves broadly ovate, cordate, acuminate, entire, smooth, finely reticulately veined, calyx cup shaped, covered with minute pellate scales, teeth minute; corolla yellow with purple base; capsules globose, covered with minutely pellated scales, surrounded at the base by persistent calyx; seeds ovoid, channelled along the back, pubescent. Flowering in May - June.

Uses : Bark is used for stomachache. Juice of leaves mixed with castor oil is a favourite remedy in inflammatory swellings. Root is used as a tonic.

22. Class : Dicotyledoneae

Sub-Class: Archichlamydeae

Order : Malvales

Family : Malvaceae

Botanical Name : Abutilon indicum, Linn.  
Vernacular Name : Pettari  
Habitat : All over Goa in hedges and waste places.  
Habit : A woody, perennial, shrub.  
Distribution : All places of Goa.  
Morphology : Leaves cordate, ovate, acuminate, toothed, rarely subtrilobate, pedicel axillary, solitary, calyx 5 - cleft, lobes ovate, apiculate; corolla yellow opening in the evening; carpels usually 15-20 shining, not owned, dark brown; seeds brownish-black, densely and minutely scrobiculate, 3 in each carpel, testa very hard, covered with simple hairs. flowering throu<sup>gh</sup>out the year.  
Uses : Leaves used as antipyretic & antiseptic, Root used for urinary and kidney infections. Bark used for urinary complaints.

23. Class : Dicotyledoneae

Sub-Class : Archichlamydeae

Order : Malvales

Family : Malvaceae

Botanical Name : Hibiscus rosa-sinensis, Linn.

Vernacular Name : Doshin.

Habitat : Cultivated in garden and grows in sandy, clay and red soil.

Habit : Shrub.

Distribution : All places of Goa.

Morphology: Leaves short petioled, ovate to ovate-lanceolate, acuminate, irregularly serrate towards top, entire near base, glabrous on both surfaces pedicels axillary, solitary, very long, involucral bracts 5 to 7; calyx puberulous with minute hairs. Corolla tubular, red, petals thrice as long as

calyx. Flowering during most of the year. (Plate V-C).

Uses : Leaves used as anti-inflammatory and anodyne. Bark used as haemostatics. Roots used in cough.

24. Class : Dicotyledoneae

Sub-Class : Archichlamydeae

Order : Malvales

Family : Sterculiaceae

Botanical Name : Helicteres isora, Linn.

Vernacular Name : Altay

Habitat : Grows in rocky soil.

Habit : A tall shrub.

Distribution : Sattari: Galauli, Caranzol, Ambechagol; Bardez: Bastora;

Sanguem: Goa border area from Anmod, Barazen mine area, Kumbhari, Bati Sidh, Netravali, Molem, Durgin hills; Quepem: Eudsari, Goundugarha; Canacona: Tudal Jamaighati, near Nadquem, Painguinim, Ordofond.

Morphology : Leaves bifarious, oblong, obovate, shortly acuminate, closely dotted on both surfaces, stellate hairs, irregularly crenate-serrate; flowers red-coloured, distinctly bilabiate, axillary clusters of 2-6 together, pedicels very short, stellately tomentose; calyx tubular, somewhat two-lipped, teeth triangular, unequal, petals red, closely reflexed on the calyx; follicles 5, beaked linear, twisted together into a form of a screw, stellately tomentose; seeds numerous, angular, testa loose, wrinkled. Flowering July to December.

Uses : Bark is used as anti-diabetic and also as a remedy for sores inside the ears. Also used for relief of stomachache. Extract of bark is especially given to children in cough for vomiting mucosa.

25. Class : Dicotyledoneae  
Sub-Class : Archichlamydeae  
Order : Malvales  
Family : Sterculiaceae  
Botanical Name : Sterculia urens, Roxb.  
Vernacular Name : Dhavorukh  
Habitat : Grows in rocky soil.  
Habit : Large tree, with white bark, smooth and papery.  
Distribution : Ilhas: Chimbel reservoir to Brahamapuri temple; Bardes: Pilerne; Sattari: Morlem, Paryem; Canacona: Ordofond, Nadquem-quer hills.  
Morphology : Leaves big, crowded at the ends of branches, shallowly palmately lobed, glabrous, velvety beneath; flowers yellow numerous, small hermaphrodite; follicles 4 - 6 ovoid oblong, densely pubescent; Seeds 3 - 6 oblong black, flowering in December - February.  
Uses : Leaves are used in lung trouble and swelling and in respiratory affections. Bark is used in diabetics and also used as tonic.

26. Class : Dicotyledoneae  
Sub-Class : Archichlamydeae  
Order : Malvales  
Family : Tiliaceae  
Botanical Name : Grewia microcos, Linn.  
Vernacular Name : Ansali  
Habitat : Grows in sandy, red and rocky soil.  
Habit : A shrub.  
Distribution : All places in Goa.

Morphology : Leaves elliptic oblong, acuminate, glabrous, entire; flowers in terminal panicles, sepals obovate, acute, torus short, lobed at apex; fruit globose, purple, globous, wrinkled, mesocarp fibrous. Flowering in May - October.

Uses : Root used in liver troubles and as an anti-inflammatory. Leaves anti-septic, bark as astringent.

27. Class : Diotyledoneae

Sub-Class : Sympetalae

Order : Oleales

Family : Oleaceae

Botanical Name : Nyctanthes arbor-tristis, Linn

Vernacular Name : Parijat

Habitat : Cultivated in garden and grows in red and clay soil.

Habit : A small tree, 15 to 20 ft. high.

Distribution : All places of Goa.

Morphology : Leaves opposite short petioled, ovate-acute, entire rough and glabrous above with short bulbous hairs; densely pubescent beneath with appressed hairs; flowers delightfully fragrant, open at night and fall in the morning, sessile in pediculate bracteate fascioles of 3-5 peduncles 4-angled, slender, hairy axillary and solitary. Calyx narrowly campanulate, hairy outside glabrous inside, corolla glabrous tube orange, lobes white, fragrant, capsules obcordate, brown when ripe; prominently veined, compressed 2-celled, separating into 2 flat, 1-seeded carpel; seed glabrous; foliaceous type; testa thin. Flowering October - November.

Uses : Decoction of leaves prepared over a gentle fire is recommended as specific for obstinate sciatica; also used as an anti-pyretic. Bark is used for cough.

28. Class : Dicotyledoneae  
Sub-Class : Archichlamydeae  
Order : Myrtales  
Family : Myrtaceae  
Botanical  
Name : Eugenia jambolana, Lamk  
Vernacular  
Name : Jambul  
Habitat : Grows in red, clay and rocky soil.  
Habit : A large evergreen tree.  
Distribu-  
tion : Sattari: Valpoi, Walanoha Dongor, Ambeacho gol, Sanguem:Molem,  
Quepem: Budsari, Goundugarha, Canacona: Maxem.  
Morphology: Leaves leathery, coriaceous, elliptic oblong, acute, smooth  
and shiny; flowers small, creamy white, fragrant, sessile, crowded in heads  
on ends of laxly panioled cymes, rising from the branches below the leaves;  
calyx rugulose, externally, shortly turbinate, limb cup-shaped, yellow in-  
side, petals calyptrate; fruit egg-shaped, dark purple, smooth, juicy, crow-  
ned with truncate calyx-limb, 1-seeded. Flowering in March - May.  
Uses : Fruits and seeds used as anti-diabetic. Leaves used in dysen-  
tery. Bark used as astringent.
29. Class : Dicotyledoneae  
Sub-Class : Archichlamydeae  
Order : Myrtales  
Family : Myrtaceae  
Botanical  
Name : Eucalyptus globulus, Labill  
Vernacular  
Name : Nilgiri  
Habitat : Grows in rocky soil.  
Habit : A middle size tree from 15 to 20 metres.

Distribu-  
tion : Sattari: Valpoi, Caranzol, Pale, Codal, Sanguem: Sidh forest,  
Molem; Canacona: Orodofond, Tudal.

Morphology: Leaves linear-lanceolate, alternate, coriaceous, entire; flow-  
ers white on axillary peduncles, bracts deciduous, calyx tube adnate at the  
base to the ovary, truncate at the apex, petals 5 united in a calyptra which  
falls off by the pressure of growing stamens; stamens many, free, filaments  
filiform, anthers small, ovary inferior, 3 to 4-celled, many ovules in each  
cell; fruit rugose capsule, dehiscent loculicidally at the mouth; Seeds small,  
angular testa membranous. Flowering in February - March.

Uses : Bark used in dysentery and leaves as anti-septic.

30. Class : Dicotyledoneae

Sub-Class : Archichlamydeae

Order : Opuntiales

Family : Myrtaceae

Botanical  
Name : Careya arborea, Roxb.

Vernacular  
Name : Kumyo

Habitat : Grows in rocky soil.

Habit : A middle size tree.

Distribu-  
tion : Sattari: Morlem, Paryem, Nagargaon; Bardez: Pilerne; Sanguem:  
Sidh forest, Kargal jungle (Netravali); Canacona: Orodofond, Tudal.

Morphology: Leaves sessile, broadly ovate, crenate, glabrous; flowers yel-  
lowish white, ill smelling, arranged at the end of the branches, calyx tube  
campanulate, petals elliptic-oblong, filaments slightly lower, petals red;  
fruit globular, green. Flowering in March - May.

Uses : Bark used as anti-inflammatory and also in coughs & colds.

31. Class : Dicotyledoneae  
Sub-Class : Archichlamydeae  
Order : Papaverales  
Family : Cappardaceae  
Botanical Name : Capparis zeylanica, Linn.  
Vernacular Name : Katya Ghosvel.  
Habitat : Grows near the hedges of the ponds in a cool type climate. It grows at the bottom of the hills where water is stagnant and requires red, rocky soil.  
Habit A A rigid, much branched thorny shrub.  
Distribution : Quepem: Balli; Cuncolim; Sanguem: Molem, Colem; Sattari: Morlem, Valpoi.  
Morphology: Leaves glabrous, coriaceous, elliptic, acute, entire; flowers white, axillary, solitary, pedicels slender, sepals nearly equal, concave, petals white oblong, obtuse, undulate, lower pair spreading; fruit irregularly ovoid, bright scarlet; seeds numerous, embedded in a white, foetid pulp. Flowering February - April.  
Uses : Roots is used as anti-septic. Also used for thornlike appearances in the throat of children.

32. Class : Dicotyledoneae  
Sub-Class : Archichlamydeae  
Order : Papaverales  
Family : Moringaceae  
Botanical Name : Moringa pterygosperma, Gaertn.  
Vernacular Name : Mashing  
Habitat : Cultivated in garden and grows in red and clay soil.

Habit : Middle size tree.

Distribu-  
tion : Most places in Goa.

Morphology: Leaves 3 - pinnate; flowers white, in large puberulous, panicles, petals spatulate, veined; fruit light brown when ripe, a foot or more in length, triangular, ribbed and composed of 3 valves, containing a soft white pulp and a single row of 42-18 seeds, which are having 3 membranous wings. Flowering in January - February.

Uses : Bark used for stomach troubles and as an inflammatory.

33. Class : Dicotyledoneae

Sub-Class : Archichlamydeae

Order : Parietales

Family : Flacourtiaceae

Botanical  
Name : Hydnocarpus wightiana, Blume.

Vernacular  
Name : Kastel

Habitat : Grows in rocky soil.

Habit : A middle size tree, 40 to 50 ft. high.

Distribu-  
tion : Pednem: Pednem-Conad; Bicholim: Usgao; Sattari: Matachi rai, near Pale (Valpoi); Sanguem: Sidh forest near Bhati; Canacona: Tudal, Nandore, Badsari village, Nadquem.

Morphology: Leaves ovate, acuminate, entire, glabrous; flowers white, solitary, sepals 5, petals 5; berry globose, tomentose; seeds obtusely angular, numerous, yellowish. Flowering March - May.

Uses : Leaves & bark used in leprosy; seeds used as a source for extraction of oil, which is used for burning lamps and also in pharmaceutical formulations.

34. Class : Dicotyledoneae  
Sub-Class : Archichlamydeae  
Order : Parietales  
Family : Flacourtiaceae  
Botanical  
Name : Casearia esculenta, Roxb.  
Vernacular  
Name : Satanguem.  
Habitat : Grows in rocky soil.  
Habit : Small tree, reaching 20 to 30 ft. high.  
Distribu-  
tion : Sattari: Nagargaon, Ambeachea gol, Caranzol, Morlem; Sanguem:  
Potiem forests, Velemol, near Chumbari, Chausaria Ghat near Netravali; Cana-  
oons: Maxem.  
Morphology: Leaves thin, coriaceous, elliptic, subacute; flowers green in  
clusters in the axils of leaves, pedicels longer than calyx, calyx glabrous,  
lobes 4 or 5 sub-orbicular; fruit ellipsoid, orange yellow, glabrous, dehi-  
sing by 2 or 3 thick valves; seeds many, covered by a large fleshy lacerate  
scarlet aril. Flowering in May - June.  
Uses : Root is used in hepatic enlargements, for piles and in diabetes.
35. Class : Dicotyledoneae  
Sub-Class : Sympetaleae  
Order : Primulales  
Family : Myrsinaceae  
Botanical  
Name : Maesa indica, Wall.  
Vernacular  
Name : Vavling  
Habitat : Grows in rocky soil.  
Habit : A large much branched shrub.

Distribu-  
tion : Sattari: Morlem, Paryem, Codal, Keri; Canacona: Bhutpal,  
Polem, Tudal, Valchem.

Morphology: Leaves ovate-oblong, acute, irregularly serrate-dentate, thin  
globose and shining above, conspicuous beneath; flowers very small, faintly  
fragrant, numerous in compound panicles, usually globose racemes, calyx  
divided rather more than half way down, lobes rotund, ovate, corolla white,  
marked with colored lines; berry globose, cream-white covered to the apex by  
persistent calyx and tipped with short style; seeds black. Flowering August-  
November. (Plate V-D).

Uses : Roots is used as blood purifier, liver tonic and anthelmintic.

36. Class : Dicotyledoneae

Sub-Class : Archichlamydeae

Order : Rhamnaceae

Botanical  
Name : Zizyphus rugosa, Lamk.

Vernacular  
Name : Chunnin

Habitat : Grows in rocky soil.

Habit : A large straggling armed shrub, sometimes climbing.

Distribu-  
tion : Bardez: Pilerne; Salcete: Raia village; Sanguem: Avelde jungle,  
Molem, Sidh forest; Canacona: Maxem, Ordofond.

Morphology: Leaves broadly elliptic, shortly acuminate, denticulate, glab-  
rous above, fulvous-tomentose beneath, prickles short, recurved; flowers in  
long peduncled tomentose, cymes, arranged along leafless spinuous branches,  
forming a panicle; calyx pubescent outside, lobes ovate, acute, petals 5-lobed,  
drupes globose, white when ripe, 1-seeded. Flowering December - February.

Uses : Bark is used to clean wounds and sores.

37. Class : Dicotyledoneae

Sub-Class : Archichlamydeae

Order : Rhamnales

Family : Rhamnaceae

Botanical

Name : Zizyphus jujuba, Lamk.

Vernacular

Name : Bor

Habitat : All types of soil.

Habit : Small branched tree.

Distribu-

tion : Pednem: Conadin Pernem; Bardez: Chapora, Kaimsua; Ilhas: Panaji on road side, Dona Paula plateau; Canacona: Ordofond.

Morphology: Leaves bifarious, ovate-elliptic, rounded at both ends, denticulate, glabrous above, covered beneath with a dense whitish or buff tomentose; flowers greenish yellow in small axillary clusters or short peduncled axillary cymes; drupes globose, fleshy, small yellow, flowering in September - October.

Uses : Bark is used in malaria, cough and in diarrhoea.

38. Class : Dicotyledoneae

Sub-Class : Archichlamydeae

Order : Ranunculales

Family : Menispermaceae

Botanical

Name : Stephania hernandifolia, Wall.

Vernacular

Name : Padvel

Habitat : Grows in red soil and rocky soil.

Habit : Slender, twining shrub of climber type.

Distribu-

tion : Sattari: Nagargaon, Valpoi, Ambeohagol, Catrim, Chorandum, Caranzol; Sanguem: Potiem forest, Baranzan, Velemol, near Chumbari, Chausaria ghat, near Netravali.

Morphology: Leaves peltate, thinly coriaceous, acute glabrous on both surfaces; flowers minute light yellow, sessile in small umbels at the ends of long stalked axillary umbels, sepals obovate, subobtusate in male and ovate acute in female, petals obovate-cuneate in both sexes; drupes solitary, subsessile, globose, endocarp deeply & sharply transversely ridged; seeds curved almost into a ring. Flowering July - August.

Uses : Root is used in urinary complaints, stomach pain, scorpion<sup>sting</sup> and also as bitter tonic. Leaves used for cure of ulcers and for dysentery.

39. Class : Dicotyledoneae

Sub-Class : Archichlamydeae

Order : Ranunculales

Family : Menispermaceae

Botanical Name : Tinospora cordifolia, Miers.

Vernacular Name : Amrutvel

Habitat : Grows on rocky soil but usually grown on trees.

Habit : An extensive, glabrous climbing shrub.

Morphology: Leaves membranous, roundish, cordate with a broad sinus, glabrous on both surfaces, subglaucous beneath; flowers yellow, males fascicled, females solitary, pedicels slender. Male flower: sepals 3 outer very small, ovate oblong, acute, the 3 inner larger membranous, suborbicular, concave, petals each loosely embracing stamen, claw cuneate, female flowers: petals cuneate, oblong with entire margin; drupes 1 to 3 dorsally convex, ventrally flat, red. Flowering in March - April.

Uses : Root used in urinary complaint. It increases peristaltic movement and causes motion. It increases hunger and food is well digested and therefore acts as tonic. Also used for liver trouble.

40. Class : Dicotyledoneae  
Sub-Class : Archichlamydeae  
Order : Ranunculales  
Family : Menispermaceae  
Botanical Name : Cocculus macrocarpus, W.A. Prodr.  
Vernacular Name : Azravel  
Habitat : Grows well in rocky soil and red soil.  
Habit : A shrub climbing to a great height.  
Distribution : Sattari: Morlem, Keri, Valpoi, Honda; Sanguem: Sidh forest, Netravali; Canacona: Bhutpal, Ordofond, Khotegao.  
Morphology : Leaves variable in shape, usually broader than long, reniform, truncate at the base, glabrous above, glaucous beneath, margin undulate; flowers yellow, faintly fragrant in fascicles, pedicels slender, sepals thin membranous, marked with purplish lines and spots, the inner sepals obovate-oblong, larger than outer, petals broadly cuneate, 3-lobed, the middle lobe immerge, lateral lobes embracing the stamen; ripe carpels 1 - 2, nearly sessile, compressed, tapering to a short neck, glaucous, style scar, conspicuous, endocarp transversely ridged; seeds double into a hook. Flowering February - March.  
Uses : Roots used as alterative.

41. Class : Dicotyledoneae  
Sub-Class : Archichlamydeae  
Order : Rosales  
Family : Leguminosae  
Sub-Family : Papilionaceae  
Botanical Name : Atylosia scarabaeoides, Benth.

Vernacular Name : Ghosvel  
Habitat : Grows in rocky soil.  
Habit : Herbaceous twiner.  
Distribution : Sattari: Morlem, Pariyam, Onda, Valpoi; Sanguem: Netravali; Bardez: Pilerne.  
Morphology : Leaves 3 - foliate, subcoriaceous, elliptic, thinly pubescent above, densely grey pubescent beneath; flowers pedicelled, 2-6 on short densely pubescent axillary peduncles; pods straight, apiculate, clothed with long soft brownish hairs, with deep obliquely transverse lines between the seeds; seeds 4 - 6. Flowering June - October.  
Uses : Extract of herb is given to children to stop the motion which expels in form of grape-like.

42. Class : Dicotyledoneae
- Sub-Class : Archichlamydeae
- Family : Leguminosae
- Sub-Family : Papilionaceae
- Botanical Name : Pterocarpus marsupium, Roxb.
- Vernacular Name : Raktaragada
- Habitat : Rocky as well as red soil.
- Habit : A large deciduous tree with a stout crooked stem and widely spreading branches.
- Distribution : Sattari: Morlem, Caranzol, Kudal; Sanguem: Netravali, Sidh forest; Canacona: Kotegao.
- Morphology : Leaflets 5 - 7, coriaceous, oblong-truncate, glabrous on both surfaces, shining above; flowers in short, lateral & terminal fusco pubescent paniculate racemes, corolla pale yellow with crisped margins; pods

1 - 2" diam. nearly circular, glabrous; seeds small. Flowering May - June.

Uses : Bark used as astringent & body pain. The bruised leaves are applied to boils, sores and skin eruptions. Roots used for body pain.

43. Class : Dicotyledoneae

Sub-Class : Archichlamydeae

Order : Rosales

Family : Leguminosae

Sub-Family : Caesalpinaceae

Botanical Name : Tamarindus indica, Linn.

Vernacular Name : Chinch

Habitat : Grows on all types of soil.

Habit : A large tree, 40 to 60 ft. high, with branches spreading.

Distribution : All places of Goa.

Morphology : Leaflets sub-sessile, 10-20 pairs, closely set on rachis, oblong, obtuse, glabrous; flowers in lax, few flowered, racemes at end of branchlets, calyx tube narrowly turbinate, subequal oblong, with pink stripes; pods slightly curved, subcompressed, scurfy; seeds 3-12 obovate, oblong truncate at the end, compressed with a shallow oblong pit on each of the flat faces obtusely 4 sided, brown and shining. Flowering May - June.

Uses : Leaves used as refrigerant. Bark as astringent.

44. Class : Dicotyledoneae

Sub-Class : Archichlamydeae

Order : Rosales

Family : Leguminosae

Sub-Family : Caesalpinaceae

Botanical Name : Cassia fistula, Linn.

Vernacular Name : Balo

Habitat : Grows on all types of soil.

Habit : A middle size tree, 30 to 40 ft. high.

Distribution : All places of Goa.

Morphology : Leaves compound paripinnate, leaflets 4 to 8 pairs, ovate-oblong, acute, bright green and glabrous above, paler and silvery pubescent beneath; flowers large in lax pendant racemes, calyx shortly corolla yellow, petals 5, obovate, shortly clawed; pods 1 to 2 ft. long, pendulous, cylindric, nearly straight, smooth, shining, brown-black, indehiscent with numerous horizontal seeds, immersed in a dark colored sweetish pulp and completely separated by transverse dissepiments; seeds broadly ovate. Flowering March - May.

Uses : Seeds used as emetic, bark as astringent and leaves & roots as purgative.

45. Class : Dicotyledoneae

Sub-Class : Archichlamydeae

Order : Rosales

Family : Leguminosae

Sub-Family : Caesalpinaceae

Botanical Name : Cassia tora, Linn.

Vernacular Name : Taikhilo

Habitat : Grows in rainy season on sandy, clay soil.

Habit : Annual fetid herb 1 - 3 ft. high.

Distribution : All places of Goa.

Morphology : Leaflets 3 pairs, opposite obovate, oblong, glaucous, membranous, close at night; flowers usually in subsessile pairs in axils of

leaves, calyx glabrous, ovate, acute, spreading, petals 5, pale yellow, sub-equal, oblong, obtuse; pods subtetragonous much curved when young, obliquely septate, puberulous, sutures very broad; seeds 25-30 rhombo-hedral with long axis in direction of pod. Flowering August - October.

Uses : Leaves used as laxative. Leaves & seeds used in skin diseases for ringworms. Roots in snake bites.

46. Class : Dicotyledoneae

Sub-Class : Archichlamydeae

Order : Rosales

Family : Leguminosae

Sub-Family : Caesalpinaceae

Botanical Name : Caesalpinia crista, Linn.

Vernacular Name : Vakeri

Habitat : Grows in rocky soil.

Habit : Robust, woody climber, branches armed with numerous prickles.

Distribution : Pednem; Conad, Terekhol; Bicholim; Pilagao, Tirla; Canacona; Maxem. Occasionally along backwaters.

Morphology : Leaflets 5 to 7 pairs, coriaceous, oblong, obtuse, dark green glabrous and shining above and pale beneath; flowers sessile, in dense spike racemes, rhachis stout, calyx densely puberulous, scarlet, petals inserted on top of calyx tube, obovate, dark orange; pods linear oblong with thickened sutures; seeds 3 - 4 obovate-oblong, testa hard. Flowering January.

Uses : Seeds used as anti-pyretic and anti-periodic. Roots used in disorders of liver. Leaves & barks used as Emmenagogue, febrifuge & anthelmintic.

47. Class : Dicotyledoneae  
Sub-Class : Archichlamydeae  
Order : Rosales  
Family : Leguminosae  
Sub-Family : Mimosaceae  
Botanical Name : Mimosa pudica, Linn.  
Vernacular Name : Lazali  
Habitat : Grows in sandy and red soil.  
Habit : A diffuse undershrub 1 - 3 ft. high.  
Distribution : All places of Goa.  
Morphology : Leaves sensitive, digitate, pinnae 1 - 2 pairs, sessile, leaflets 11 - 20 pairs, sessile, coriaceous, linear, oblong, acute, glabrous above, clothed with appressed bristles beneath; flowers 4 - merous, pink, in globose heads, calyx very minute, corolla pink, lobes 4, ovate-oblong, obtuse; pods flat, slightly recurved, consisting of 3 - 5 one seeded joints which fall away from persistent sutures, which are clothed with spreading yellowish weak bristles; the faces of pods globrous. Flowering September - October.  
Uses : Leaves used as haemostatic, in piles and fistula, Leaves rubbed into a paste and applied to hydrocele. Also used in scorpion stings.
48. Class : Dicotyledoneae  
Sub-Class : Archichlamydeae  
Order : Rutales  
Family : Rutaceae  
Botanical Name : Glycosmis pentaphylla, DC prodr.  
Vernacular Name : Menki

Habitat : Grows in rocky soil.

Habit : Erect shrub.

Distribution : Sattari: Caranzol hill, Nanacha dongar, Codal, Thanem, Satrem, Ambecha gol, Kawaliayan forest near Nandora, South of Kudal; Sanguem: Avelde Jungle, Molem, Goa area after Anmod, Sidh forest near Bati; Canacona: Nadquem forest, Jalan, Barsare village.

Morphology : Leaflets sub sessile, alternate; flowers small, crowded in small clusters, in erect axillary panicles, pedicels very short, bracts beneath calyx triangular, calyx small, petals imbricate, white, very broadly obovate, margins embranous, berry globose, apiculate smooth, pinkish white or cream coloured. Flowering October - November.

Uses : Roots are used as anti-pyretic and for snake bite.

49. Class P Dicotyledoneae

Sub-Class : Archichlamydeae

Order : Rutales

Family : Rutaceae

Botanical Name : Citrus medica, Linn

Vernacular Name : Mavling

Habitat : Grows in rocky soil.

Habit : A low shrub.

Distribution : Sattari: Kedgi forest, Namdore, Morlem, Sanguem: Avelde Jungle; Canacona: Nadquem.

Morphology : Leaves 1-foliolate, leaflets elliptic, ovate crenate-serrate; flowers white usually tinged with red, small unisexual, 5 - 10 in a raceme, fruit globose often mammilate at the apex, usually yellow when ripe, Flowering almost the whole year.

Uses : Extract of roots is used as blood tonic, for stomachache and in diabetis. Leaves used as anti-pyretic, specially used for children at time of vomitting or giving milk.

50. Class : Dicotyledoneae

Sub-Class : Archichlamydeae

Order : Rutales

Family : Rutaceae

Botanical

Name : Zanthoxylum rhetsa (Roxb) D.C.

Vern. Name : Tephali

Habitat : Grows in rocky soil.

Habit : A middle size tree, covered all over with sharp curved or straight prickles.

Distribu-

tion : Bicholim: Nanora forest; Sattari: Onda, Morlem; Bardez: Betim hill, Bastora; Sanguem: Butabaicha dongor near verlem; Canacona: Orodofond.

Morphology : Leaves crowded at the end of branches, leaflet 8 - 20 pairs opposite, ovate-oblong, entire, glabrous; flowers yellow, small, in large terminal paniculate cymes often more than 12" broad, peduncles very long, petals 4, elliptic, yellow valvate; ripe carpels, spherical, rugose; fruits appear in bunches, when unripe they are green but on drying they become black; seeds globose, bluish black, smooth, and shining. Flowering in July-October.

Uses : Bark used for children to apply on tongue if pronunciation does not come properly. Also used for gas trouble and dysentery.

51. Class : <sup>i</sup>Dicotyledoneae

Sub-Class : Archichlamydeae

Order : Rutales

Family : Rutaceae

Botanical Name : Murraya koenigii, Spreng  
Vernacular Name : Karabil  
Habitat : Cultivated in garden and grows in all types of soil.  
Habit : A small tree with dark grey bark.  
Distribution : Pednem: Tamboim; Sattari: Valpoi, Siranguli near Caranzol.  
Morphology : Leaves imparipinnate, leaflets 11-25, alternate, serrated, obliquely ovate, tip usually notched, the lower leaflets much smaller than upper ones, irregularly crenate-dentate, glabrous above, pubescent beneath, petioles reddish; flowers white in much branched terminal peduncled corimbose cymes; fruits ovoid, apiculate, rough with glands, black 2-seeded.  
 Flowering in March - April.  
Uses : Leaves used to stop vomitting and as antipyretic and also used in dysentry and to cure skin eruptions.

52. Class : Dicotyledoneae  
Sub-Class : Arochichlamydeae  
Order : Santalales  
Family : Olacaceae  
Botanical Name : Cansjera rheedii, Gmel.  
Vernacular Name : Deplus  
Habitat : Grows in rocky soil.  
Habit : Climbing shrub.  
Distribution : Ilhas: Plateau on way from Military camp to Chimbel reservoir; Sanguem: Verlem; Sattari: Morlem, Pariyem.  
Morphology : Leaves thinly coriaceous, oblong-lanceolate, glabrous on both surfaces, base narrow, often slightly inquilateral, main nerves 3 to 5 pairs,

curved, ascending; flowers in pubescent axillary spikes, 1 or 2 spikes from an axil, bracts minute, linear lanceolate, one at the base of each flower, perianth pubescent externally, urceolate, 4 - 5 toothed, the apices of teeth recurved; fruit ovoid, orange-red, surmounted by the remains of style, glabrous. Flowering November - December.

Uses : Roots are used for cold and headache.

53. Class : Dicotyledoneae

Sub-Class : Archichlamydeae

Order : Sapindales

Family : Sapindaceae

Botanical Name : Allophylus cobbe, Blume.

Vernacular Name : Ritho

Habitat : Grows in rocky soil.

Habit : A shrub.

Distribution : Bicholim; Nanora forest; Sattari: Colem, Caranzol hills, Codal forest; Bardez: Pilerne; Sanguem: Vilujan forest; Canacona: Ordofond, Bhutpal.

Morphology : Leaves 3 - foliate, alternate, crowded at the extremities of the branchlets, drooping, leaflets ovate, acute, serrate-dentate pubescent on both surfaces, the terminal leaflet acute at the base, lateral leaflets rounded; flowers small, white, shortly pedicelled, in fascicles along the branches of spicate axillary, 2-4 branched racemes; fruit globose, smooth, red when ripe. Flowering in May - August.

Uses : Roots are used as anthelmintic, expectorant, in gas trouble and as anti-dote for scorpion and insect stings. Barks as astringent. Fruits are used for washing clothes as a substitute for soap.

54. Class : Dicotyledoneae  
Sub-Class : Archichlamydeae  
Order : Sapindales  
Family : Anacardiaceae  
Botanical Name : Spondias pinnata, Kurz.  
Vernacular Name : Amado  
Habitat : Cultivated in gardens, it grows in red, clay and sandy soils.  
Habit : A glabrous middle size tree, 30 - 35 ft. high.  
Distribution : All over Goa.  
Morphology : Leaves compound type, leaflets 3 - 5 pairs and a terminal one, oblong, acuminate, entire; flowers 1 or 2 sexual, sessile, numerous, pinkish green in sparingly branched glabrous terminal panicles; drupes ovoid, yellow, stone woody, hard, rough with irregular furrows and cavities. Flowering February - April.  
Uses : Bark used as astringent in dysentery and also used in rheumatism.
55. Class : Dicotyledoneae  
Sub-Class : Sympetalae  
Order : Tubiflorales  
Family : Acanthaceae  
Botanical Name : Adhatoda vasica, Nees  
Vernacular Name : Adoso  
Habitat : Grows in all types of soil.  
Habit : A dense shrub, 4 - 8 ft. high.  
Distribution : Pednem; Tamboxim; Canacona; Ordofond and all other places

in Goa.

Morphology : Leaves opposite, elliptic lanceolate, acuminate, short petioled, entire and simple; flowers large, white, with small ferruginous dots, the lower part of both lips streaked with purple, calyx 5-parted, corolla ringent, tube short, upperlip vaulted emerginate, lower lip broad and deeply 3-parted, both streaked with purple, filaments long resting under the vault of the upper lip, anthers twin, carpels 2, united, ovary superior; fruit capsule, clavate, subacute, bluntly pointed, pubescent; seeds orbicular, oblong, tubercular-verruucose, glabrous. Flowering in August - November.

Uses : Leaves used in cough and cold and also applied to cuts to stop bleeding. Roots used for malaria and ph<sup>h</sup>t<sub>h</sub>isis.

56. Class : Dicotyledoneae

Sub-Class : Sympetalae

Order : Tubiflorales

Family : Acanthaceae

Botanical Name : Andrographis paniculata, Nees.

Vernacular Name : Kiraitem

Habitat : Grows in rocky and sandy soil.

Habit : Annual herb.

Distribution : All over Goa.

Morphology : Leaves opposite on short petioles, lanceolate, entire, upper surface dark green and shining, under surface paler and finely granular, they vary much in size but the larger are usually about 3" in length and 1" in breadth, calyx deeply 5-cleft, corolla bilabiate, lips linear, reflected, upper one 3-toothed, lower one 2-toothed, flowers remote alternate, on long petioles, downy, rose-coloured, or white streaked with purple; capsules erect, somewhat cylindrical; seeds 3 to 4 in each. Flowering in Septem-

ber - October.

Uses : It is used for stomachache and as an anti-pyretic.

57. Class : Dicotyledoneae

Sub-Class : Sympetalae

Order : Tubiflorales

Family : Bignoniaceae

Botanical Name : Oroxylum indicum, Vent

Vernacular Name : Donduk

Habitat : Grows in rocky soil.

Habit : A small tree, 25 to 40' high branched at the top.

Distribution : Bisholim: Mayem hills; Sattari: Pale, Morlem, Codal, Nandore, Valpoi, Golauli; Sanguem: Choraudem, Netravali, Molem, Dudhsagar; Bardes: Pilerne.

Morphology : Leaflets 2 - 4 pairs, ovate, acuminate, glabrous, base rounded; flowers numerous appear in groups just before rainy season, fetid in large erect racemes, calyx leathery, oblong-campanulate, glabrous, corolla lurid-purple, fleshy; capsules long, straight, tapering at both ends, flat; seeds very numerous, membranaceous, surrounded with a large delicate membranaceous wing. Flowering in May - July.

Uses : Extract of bark is mixed with groundnut oil and put into ear in case of flowing of ears; also used as astringent, anodyne and for gas troubles.

58. Class : Dicotyledoneae

Sub-Class : Sympetalae

Order : Tubiflorales

Family : Labiatae

Botanical Name : Leucas aspera, Spreng.

Vernacular Name : Tumo

Habitat : Grows in rainy season, in cool place and dies in summer.

Grows on any type of soil.

Habit : An annual, pubescent herb.

Distribution : All places of Goa.

Morphology : Stems erect, usually much diffusely branched from below, stout branches, quadra-angular, leaves sessile, linear-oblong, obtuse; flowers sessile in terminal and axillary whorls, calyx tubular, tube curved, corolla white. Flowering in October.

Uses : Juice of leaf is applied in psoriasis, scabies & skin eruptions. Also useful in chronic rheumatism & as an insecticide. Roots used as anti-pyretic.

59. Class : Dicotyledoneae

Sub-Class : Sympetalae

Order : Tubiflorales

Family : Solanaceae

Botanical Name : Datura metel, Linn.

Vernacular Name : Dhotro

Habitat : Usually found in wastelands.

Habit : Annual shrub.

Distribution : In all places of Goa, wherever there is waste water flowing and areas containing decayed vegetation. Often cultivated.

Morphology : Leaves have long petioles, ovate, acute, sinuate-dentate, glaucous, green above, paler beneath; flowers large, trumpet shaped, purple

outside, white inside, solitary, pedicels short, corolla 7" long, 4 - 5" across at the mouth; limb of corolla is 10-toothed; fruit is an ovoid capsule thickly studded with blunt spines. It is biocular containing a large number of flattened, kidney shaped, black seeds; seeds finally pitted, marked with coarser series of shallow reticulations. Flowering in September - October.

Uses : Leaves used for respiratory diseases and an anti-inflammatory.

60. Class : Dicotyledoneae

Sub-Class : Sympetalae

Order : Tubiflorales

Family : Verbenaceae

Botanical Name : Lantana camara, Linn.

Vernacular Name : Ghaneri

Habitat : Grows in red, sandy, clay soil.

Habit : A straggling shrub with an odour of black currants.

Distribution : Pednem: Terekhol; Sattari: Caranzol, Deosati, Satrem, Morlem; Bardez: Betim; Ilhas: Panaji along sea coast.

Morphology : Leaves in whorls of 3, ovate, acute, crenate-serrate, surface is rugose and finely pubescent above, soft white pubescent beneath, base is rounded; flowers orange coloured. Flowering more or less throughout the year.

Uses : Leaves used as an antiseptic, in rheumatism, in malaria and much used in atony of abdominal viscera.

61. Class : Dicotyledoneae

Sub-Class : Sympetalae

Order : Tubiflorales

Family : Verbenaceae

Botanical Name : Vitex negundo, Linn.

Vernacular Name : Lingod

Habitat : Grows in all types of soil.

Habit : A large shrub.

Distribution : Sattari: Valpoi, Codal forest, Thanem; Bardez: Pilerne; Ilhas: Panaji along sea coast; Salcete: Verna village plateau; Canacona: Nadquem village. Common along the water courses near the villages and as hedges along the ricefields.

Morphology : Leave 3 to 5 foliate, leaflets lanceolate, acute; flowers in pedunculate branched tomentose cymes, opposite along the quadra-angular tomentose rhachis of a large termina often compound pyramidal panicle, calyx white tomentose, corolla bluish purple, tomentose; drupes black when ripe. Flowering more or less throughout the year.

Uses : Leaves used as a discutient fomentation in sprains, rheumatism, swelled testicles, etc. Root is used as tonic and also as expectorant.

62. Class : Dicotyledoneae

Sub-Class : Sympetalae

Order : Tubiflorales

Family : Verbenaceae

Botanical Name : Gmelina arborea, Roxb.

Vernacular Name : Shivan

Habitat : Grows in rocky soil.

Habit : A moderate sized, unarmed deciduous tree, reaching 60' high.

Distribution : Sattari: Morlem, Codal, Onda; Sanguem: Netravali; Canacona: Khotigao.

Morphology : Leaves broadly ovate, acuminate, entire, glabrous when mature, stellately fulvous, tomentose beneath; flowers numerous, yellow, in small cymes calyx broadly campanulate, densely fulvous, hairy teeth 5-small triangular, acute corolla brownish yellow, densely hairy outside, 5-lobed; drupe 1 or 2 seeded, ovoid, smooth, orange, yellow when ripe. Flowering in March - May.

Uses : Extract bark is given to children to vomit milk so that their stomach becomes clean and further digestion is better. Also mucous goes out and the child is relieved of cough.

63. Class : Dicotyledoneae

Sub-Class : Archichlamydeae

Order : Urticales

Family : Urticaceae

Botanical Name : Ficus bengalensis, Linn.

Vernacular Name : Wad

Habitat : In any type of soil, it grows.

Habit : A very large tree, reaching 100' high, sending down many aerial roots from the branches.

Distribution : All places of Goa.

Morphology : Leaves coriaceous, ovate to elliptic, obtuse, entire, glabrescent above, glabrous beneath, receptacles sessile in pairs, axillary, red when ripe with 3 broad rounded nearly glabrous, coriaceous, basal bracts. Male flowers rather numerous near the mouth of the receptacle. Gall flower perianthe as in male, style short; fertile flower, perianth shorter than in males, style elongate; fruit red when ripe. Flowering in April - June.

Uses : Bark is used to reduce urine. Fruit as an anti-diabetic and the root tips of the advantageous roots used as antiemetic and also antidiabetic.

64. Class : Monocotyledoneae  
Order : Graminales  
Family : Gramineae  
Botanical Name : Arundinella gigantea, Dalz.  
Vernacular Name : Jivnal  
Habitat : Cultivated in garden and grows in clay, rocky soil.  
Habit : A tall grass.  
Distribution : Sattari: Morlem, Pariyem; Ilhas: Corlim; Canacona: Maxem.  
Morphology : Leaves linear, lanceolate, finely acuminate, glabrous, sheath striate almost glabrous; ligule a narrow glabrous membran<sup>e</sup>, panicle subcorimbosely thyriform, rachis stout, angular, concealed by numerous erect angular branches; glumes 4, lower involucre glume, broadly ovate, acute, upper involucre glume, ovate, lower floral glume ovate, subobtuse, upper floral glume elliptic thickly coriaceous, white. Flowering in October. (Plate VI-A)  
Uses : bowel complaint in children.
65. Class : Monocotyledoneae  
Order : Graminales  
Family : Gramineae  
Botanical Name : Cymbopogon citratus, Starf.  
Vernacular Name : Ganjan  
Habitat : Cultivated in garden and grows in sandy clay & red soil.  
Habit : A tall, sweet, scented grass, 5 - 8 ft. high with glabrous straw-colored leafy stems.  
Distribution : All places in Goa.  
Morphology : Leaves subcordate at base, more or less glaucous beneath,

tapering from a little above the base or from the middle to a fine tip; flowers in pairs, one hermaphrodite and sessile, the other male and pedicelled. The last hermaphrodite flower of each spike, has 2 males; below there is only one male, as the rachis occupies the space of the other. Hermaphrodite flowers sessile. Glume girt at the base with wool, corolla 2-valved, awnless, nectary, two, broad, short, wedge formed, obliquely lobed; male flowers pedicelled, calyx, glumes as in hermaphrodite ones. Corolla 1-valved awnless. Nectary as in hermaphrodite, stamens three. Flowering in rainy season.

Uses : Leaves used as carminative, stimulant and antiperiodic.

66. Class : Monocotyledoneae

Order : Liliales

Family : Liliaceae

Botanical Name : Asparagus racemosus, Willd.

Vernacular Name : Sosro

Habitat : Grows in rocky soil.

Habit : An extensively scandent, woody shrub.

Distribution : Sattari: Morlem, Codal; Sanguem: Perichetem; Canacona: Amdiga near Butpal, Nadquem, Orodofond.

Morphology : Leaves linear, subulate, with a stout conical spinuous spur, slightly curved; cladode, very slender spinuous, pointed; flowers white, fragrant, in simple racemes, rachis 3-quetrous with several cladodes along it increasing in number towards apex which is often crowned with a tuft of them; berry - globose, red when ripe. Flowering in June - September.

Uses : Roots are used to remove bilious & rheumatic humours, and in blood diseases. Also used for urinary disorders.

67. Class : Monocotyledoneae

Order : Liliales  
Family : Liliaceae  
Botanical Name : Smilax macrophylla, Roxb.  
Vernacular Name : Sarsaparilla  
Habitat : Grows in rocky soil.  
Habit : A large, climber.  
Distribution : Pednem: Cargo; Sattari: Valpoi-Nagram, Wolancha Dongar, Caranzol, Nandore Road side, Codal, Ivorem, Buzruco, Morlem; Bardez: Pilerne, Socorro villate; Ilhas : Chimbil reservoir, Brahamapuri temple; Salcete: Raia village, Margao-Borim; Sanguem: Durgin forest, Choraundem, Molem, Verlem, Bati Sidh; Quepem: Budsari - Gaoundugarha; Canacona: Ordo-fond, Parsol Hill, Pahad near Nadquem.  
Morphology : Leaves alternate, ovate, acuminate, glabrous, polished; flowers in pedunculate, many flowered umbels, male flowers, perianth segments, linear, obtuse, female flowers perianth rather shorter than male; segments reflexed; berry spherical, smooth, remaining green for a long time; becoming red when ripe. Flowering in August.  
Uses : Roots are used in skin diseases and as blood purifier. Mainly used for venereal complaints.

68. Class : Monocotyledoneae  
Order : Scitaminales  
Family : Zingiberaceae  
Botanical Name : Curcuma zedoaria, Rose.  
Vernacular Name : Ambehalad  
Habitat : Grows in rocky soil.  
Habit : A rootstock of palmately branched, sessile cylindrical oblong

annulate tubers.

Distribu-  
tion : Sattari: Morlem, Paryem, Codal forest, Satrem, Caranzol;  
Canacona: Potiem forest, Moira forest.

Morphology : Leaves with long petiols, 1-2 ft. long, oblong lanceolate, finally acuminate, glabrous, on both surfaces; flowering stem 8 - 10" long appearing before the leaves, stout, clothed with obtuse sheaths; flowers yellow in spikes, flowering bracts ovate, recurved, cymbiform, green tinged with red, bracts of coma reachin 2" long, crimson or purple, calyx obtusely 3-toothed, corolla tube twice as long as calyx, funnel shaped, lateral lobes, oblong, dorsal lobe larger, arching over the anther, lip suborbicular, deflexed, obscurely 3-lobed, deep yellow; capsule ovoid, 3-gonous, thin, smooth, bursting irregularly; seeds ellipsoid with a white lacerate aril. Flowering in July - September. (Plate VI-B)

Uses : Rhizome is powdered and applied to body when a person is suffering from cold, to relieve the body-ache. Also used as diuretic. It also checks leucorrhoeal and gonorrhoeal discharges and purifies the blood.

The juice of the leaves is given in dropsy.

69. Class : Monocotyledoneae
- Order : Scitaminales
- Family : Zingiberaceae
- Botanical  
Name : Kaempferia rotunda, Linn.
- Vernacular  
Name : Bhuim-chamfa
- Habitat : Grows in rocky soil as well as clay soil in areas with decayed vegetation. Requires cold climate.
- Habit : It is a fragrant, stemless herb with tuberous roots.
- Distribu-  
tion : Sattari: Morlem, Paryem; Bicholim: Kudchirem; Kundai.

PLATE - VI

A Arundinella gigantea, Dalz.

B Curcuma zedoaria, Rose.

C Kaempferia rotunda, Linn.

D Lygodium flexuosum, Linn.

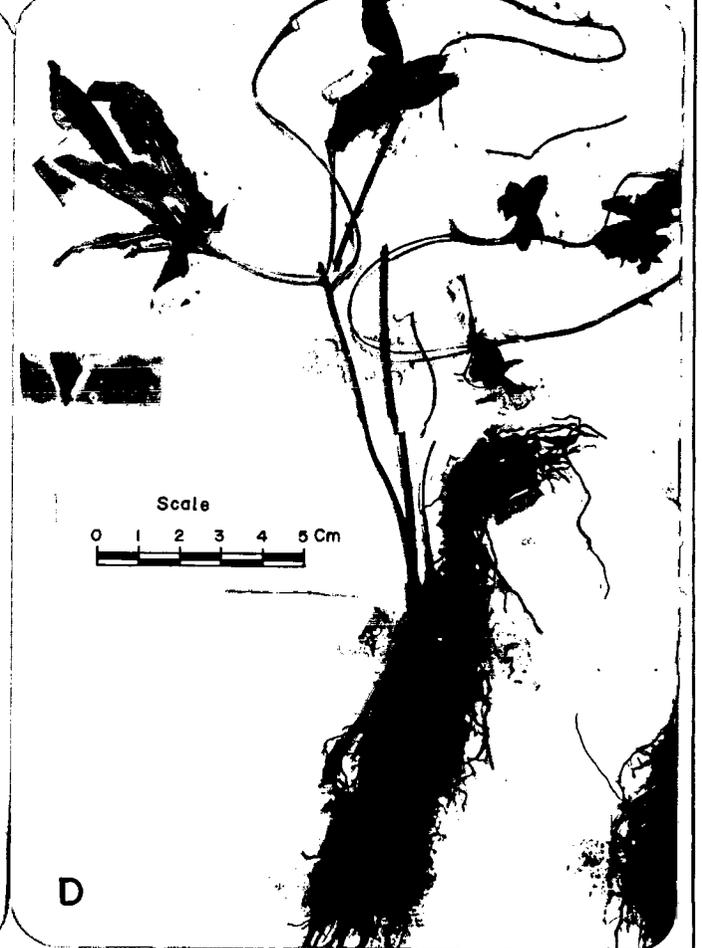
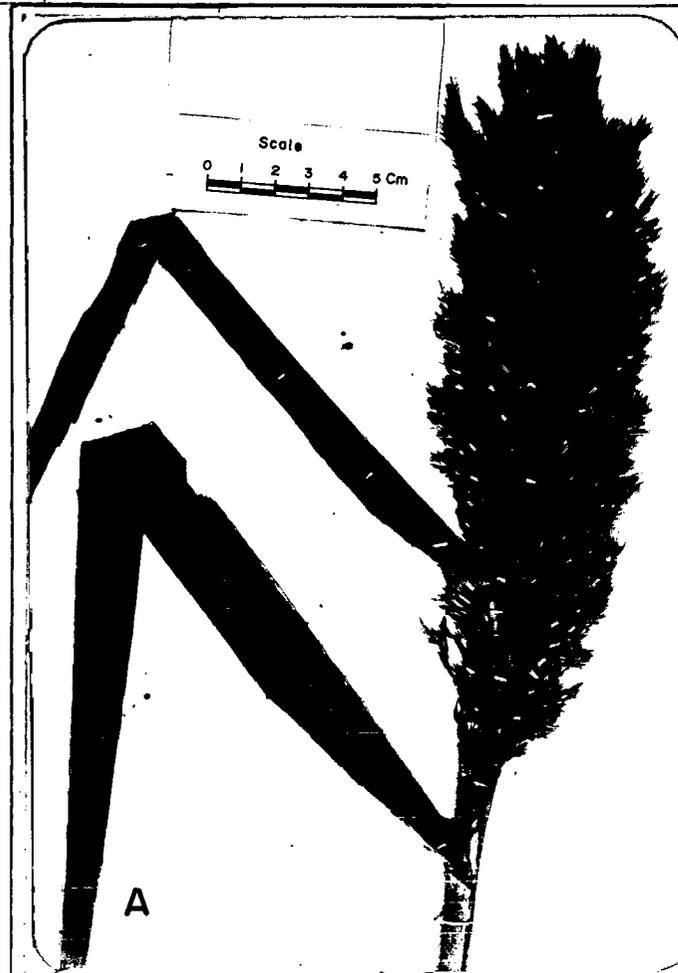


PLATE VI

Morphology : Roots sprout in groups and are fleshy. They appear like eggs. Leaves oblong, few, erect, noninate and pale red-purple beneath. Flowers sweetly fragrant, of various shades of purple and white. Flowering in April. (Plate VI-C).

Uses : Externally used in cure of mumps. Internally used as appetiser and as antidote for snake bite.

70. Phylum : Pteridophyta  
Class : Filicineae  
Order : Ficales  
Family : Schizaeaceae  
Botanical Name : Lygodium flexuosum (Linn) Swartz.

Vernacular Name : Kallim Palam

Habitat : Grows in rocky soil & requires cold climate.

Habit : A graceful, climbing herb.

Distribution : Bicholim: Mayem forest; Sattari: Valpoi Nagram, Nanachadongar, Codal, Waddicha dongar, Caranzol; Bardez: Pilerne; Sanguem: Molem, Kumbhari, Bati Sidh; Quepem: Budsari, Goundugarha; Canacona: Barsare village, near Tudol, Nadquem-Keri hills, Ordofond.

Morphology : Herb with wide, twining stems, fronds, scandent, pinnae, conjugate, with serrulate margins, palmately lobes, pinnatifid, veins free, forked, sporangia solitary or casually paired in the axils of large imbricated, clasping indusia, that forms spikes either on separate pinnae or in lax rows along the margin of leafy ones. Flowering in September - November. (Plate VI-D)

Uses : Roots are used as antipyretic and for cold.



## CHAPTER IV

# MICROSCOPICAL CHARACTERS OF THE CRUDE DRUGS

## CHAPTER IV

### MICROSCOPICAL CHARACTERS OF THE CRUDE DRUGS

Evaluation of crude drugs involves identification of the drug and finding out its quality and purity. Unless the drug is not properly identified, finding out the intrinsic value of the drug has no meaning. Therefore, first of all the identity of the drug should be established. This identity can be established by finding out the actual source from which the drug is obtained or by comparing it with the samples kept in the museum or by means of morphological characters. However in case of doubt, confirmation of the identity can be obtained by the study of histologic characteristics of the whole drugs. But unfortunately characters in whole drugs are not prominent for measuring the dimensions. Moreover, when the crude drug is powdered, histologic arrangement of the whole drug is lost. Therefore, the anatomical diagnostic characters of the drugs are best described when studied in powdered conditions. The drugs selected for the study were powdered and the structures were studied by drawing them on paper with the help of camera lucida and their dimensions were measured by calibrated eye piece micrometer. It was found that magnifications of 16 x eye piece and 10 x objective & 45 x objective were 2.2  $\mu$  and 10  $\mu$  respectively. These values were used for the multiplication of the divisions of eye piece micrometer coinciding with the structures. The Table-3 gives the results of the characters of powders of roots and rhizomes. Table-4 gives the results of characters of powder of seeds. Table-5 give the results of character of powders of leaves. Table-6 gives the results of powders of barks.

T A B L E - 3  
MICROSCOPIC CHARACTERS OF POWDERED ROOTS AND RHIZOMES

S.No.	Name of the drug	Fibre	Calcium oxalate	Stone cells	Starch grains	Special features
1	2	3	4	5	6	7
1.	<u>Adhatoda vasica</u>	Many groups, individual upto 580 $\mu$ long.	---	Groups.	---	---
2.	<u>Rhynchospora serpentina</u>	Groups.	---	---	Many.	Polygonal shaped lignified cells.
3.	<u>Hemidesmus indicus</u>	Few isolated upto 490 $\mu$ long.	---	Few isodiametric of 80 $\mu$ long.	Many.	---
4.	<u>Capparis revlanica</u>	Isolated 300 - 430 $\mu$ long.	---	Few subrectangular isolated of 40 $\mu$ diameter. Groups of 2-4 components.	Few.	---
5.	<u>Viburnum foetidum</u>	Fibre with bordered pits.	Clusters.	---	---	Few secretory cells.
6.	<u>Momordica dioica</u>	---	---	Groups of 3 or more individual 100 $\mu$ long & 40 $\mu$ wide.	---	Lignified pitted polygonal cells.
7.	<u>Croton oblongifolius</u>	Groups many.	Clusters abundant of 40 $\mu$ diameter.	---	Few	Reddish brown oval shaped cells of 40 $\mu$ diameter. Also lignified polygonal cells.
8.	<u>Cassia esculenta</u>	Groups. Few septate.	Few prisms.	---	---	---

Table-3 continued...

1	2	3	4	5	6	7
9.	<u>Leuca aspera</u>	Groups.	—	—	—	—
10.	<u>Pterocarpus marsupium</u>	Isolated 380 - 630 $\mu$ long.	—	—	Few.	—
11.	<u>Cassalpinia crista</u>	—	Abundant prisms.	Few oval of 40 $\mu$ diameter. Groups of 2 - 4 components.	Few.	Pigment cells with reddish contents.
12.	<u>Stephania bernandifolia</u>	—	—	Few isolated of 50 $\mu$ width and 100 $\mu$ length. Groups of 2 - 5 components.	Abundant.	Large parenchymatous cells.
13.	<u>Tinospora cordifolia</u>	Few isolated of 360 $\mu$ long.	Few prisms.	Isolated few of 30 $\mu$ width and 40 $\mu$ length. Groups of 10 - 12 components.	Abundant of eccentric type.	—
14.	<u>Cocculus macrocarpus</u>	Septate Fibres.	—	Groups of 3 or more individual 30 x 50 $\mu$ .	Many.	—
15.	<u>Moesa indica</u>	Isolated of 350 - 500 $\mu$ long.	Few prisms.	Few oval upto 190 $\mu$ long.	Many.	—
16.	<u>Cassipouera rheedii</u>	Individual 280 - 500 $\mu$ long.	Few prisms.	—	Many.	Groups of lignified fibres.
17.	<u>Ixora parviflora</u>	Few upto 120 $\mu$ long. Groups also present.	—	—	—	Few cylindrical shaped lignified cells.

Table-3 continued...

1	2	3	4	5	6	7
18.	<u>Paederia foetida</u>	Few isolated pitted. Groups also present.	Abundant clusters.	Few isolated of 30 $\mu$ width & maximum 130 $\mu$ long. Groups of 4 - 10 components.	—	—
19.	<u>Glycosmia pentaphylla</u>	Fibres pitted. Clusters & septate, upto 180 $\mu$ long.	—	—	—	—
20.	<u>Citrus medica</u>	Few isolated faintly lignified upto 650 $\mu$ long.	Few prisms.	—	Few.	—
21.	<u>Grewia microcos</u>	Groups of fibres seen in radial longitudinal view.	—	—	Few.	—
22.	<u>Vitex negundo</u>	—	Abundant prisms.	—	Few.	—
23.	<u>Arundinella gigantea</u>	Pitted.	—	—	Few.	Big masses of lignified structures.
24.	<u>Asparagus racemosus</u>	—	—	—	Few.	—
25.	<u>Smilax macrophylla</u>	—	—	—	Few.	—
26.	<u>Curouma zedoaria</u>	Few of 30 $\mu$ width & 500 $\mu$ length. Groups present.	—	—	Abundant eccentric.	Yellowish oleo-resin cells. Non-lignified scalariform xylem vessels.

Table-3 continued..

1	2	3	4	5	6	7
27.	<u>Knemferia rotunda</u>	—	—	—	Abundant ovoid.	Pale straw coloured cells. Non-lignified scalariform xylem vessels.
28.	<u>Lygodium flexuosum</u>	Groups.	—	—	—	Masses of black pig- ment cells.

T A B L E - 4  
MICROSCOPIC CHARACTERS OF POWDERED SEEDS

S.No.	Name of the drug	Aleurone grains	Endosperm	Special features
1	2	3	4	5
1.	<u>Ricinus communis</u>	Well defined with crystalloid & globoid.	Thick walled cells containing droplets of oil.	Few long celled trichomes.
2.	<u>Hydnocarpus wightiana</u>	Irregular shaped.	Thick walled cells.	---
3.	<u>Cassia tora</u>	Irregular shaped.	Thick walled cells.	---
4.	<u>Strychnos nux-vomica</u>	Irregular shaped containing only crystalloid.	Thin walled cells showing fine lines.	Abundant lignified ribs of trichomes.

TABLE - 5  
MICROSCOPIC CHARACTERS OF POWDERED LEAVES

S.No.	Name of the drug	Fibre	Calcium oxalate	Starch grain	Stomata	Trichome	Special features
1	2	3	4	5	6	7	8
1.	<u>Adhatoda vasica</u>	---	---	---	Caryophyllaceous	Multicellular few of 130 - 150 $\mu$ long.	Few quadricellular glandular trichomes.
2.	<u>Andrographis paniculata</u>	---	Few clusters.	Few	Caryophyllaceous	Glandular trichomes with unicellular head & stalk.	---
3.	<u>Annona squamosa</u>	Groups. Indi- vidual upto 160 $\mu$ long.	Few prisms.	---	Rubiaceous.	Multicellular 140 - 200 $\mu$ long.	Few secretory cells.
4.	<u>Calotropis gigantea</u>	---	---	---	Rubiaceous with striated cuticle.	---	Few laticiferous tubes.
5.	<u>Croton oblongifolius</u>	---	Prisms & clusters	Few	Rubiaceous.	Star shaped peltate.	Portions of 2 - armed trichomes.
6.	<u>Ricinus communis</u>	---	Abundant clusters of 30 - 60 $\mu$ dia- meter.	---	Rubiaceous.	---	---
7.	<u>Leucaena aspera</u>	---	Few prisms.	---	Caryophyllaceous.	Abundant multi- cellular 120 - 350 $\mu$ long. Glandular head with short stalk & head with 1 - 16 cells.	---

Table-5 continued...

1	2	3	4	5	6	7	8
8.	<u>Pterocarpus marsupium</u>	Groups.	Few prisms.	Many	Rubiaceous. Specia- lly with 3 subsi- diary cells.	Unicellular of 70- 110 $\mu$ long. Feltate & club shaped glands are seen.	---
9.	<u>Tamarindus indica</u>	Groups.	---	---	Ranunculaceous.	Unicellular.	Secretary-cells.
10.	<u>Cassia fistula</u>	Few with idioblast containing prisms.	Few prisms.	Few	Rubiaceous.	Abundant Unicel- lular 60-150 $\mu$ long.	Stellate & glandular hairs.
11.	<u>Mimosa pudica</u>	Few.	Solitary.	---	Rubiaceous.	Branched sleggy trichomes & few glandular with & multicellular stalk & head.	---
12.	<u>Atylosia scarabaeoides</u>	Few	Few prisms & olusters.	---	Ranunculaceous.	Unicellular	---
13.	<u>Thespesia polulnea</u>	---	Clusters Abundant.	Few	Ranunculaceous.	Feltate & capi- tate glandular trichomes.	Striated cuticle.
14.	<u>Abutilon indicum.</u>	---	Clusters few.	---	Ranunculaceous.	Unicellular, 70 - 130 $\mu$ long, multi- cellular trichomes few about 590 $\mu$ inlength.	Radiate shaped feltate trichomes.

Table-5 continued...

1	2	3	4	5	6	7	8
15.	<u>Hibiscus rosa-sinensis</u>	—	Few clusters.	Few	Ranunculaceous.	Feltate hairs.	Oval shaped yellowish cells & mucilaginous cells.
16.	<u>Tinospora cordifolia</u>	Groups.	—	—	Ranunculaceous.	Uniseriate of more than 2 cells. Some are bent.	Club shaped glandular trichome.
17.	<u>Eugenia jambolana</u>	Groups.	Few clusters.	—	Ranunculaceous.	Unicellular.	Secretory cavities.
18.	<u>Boerhaavia diffusa</u>	Groups.	Abundant needle shaped.	Scanty.	Ranunculaceous.	Few unicellular about 140 $\mu$ long. Few multi-cellular with blunt terminal cells.	—
19.	<u>Nyctanthes arbor-tristis</u>	—	—	—	Ranunculaceous.	Unicellular from 170 - 430 $\mu$ long.	
20.	<u>Averrhoa bilimbi</u>	—	Few prisms & clusters.	—	Rubiaceous.	Unicellular 140 - 460 $\mu$ long. Also glandular hairs with unicellular head.	Some trichomes stain red.
21.	<u>Oldenlandia corymbosa</u>	Groups.	Few raphides.	—	Rubiaceous.	—	Irregular shaped masses of lignified structures.

Table-5 continued...

1	2	3	4	5	6	7	8
22.	<u>Psychotria truncata</u>	Groups.	Few raphides.	---	Rubiceous.	Unicellular. Few 140 - 200 $\mu$ .	Secretary cells.
23.	<u>Murraya koenigii</u>	---	Abundant Clusters crystals.	---	Ranunculaceous.	Unicellular & few are peltate.	Secretary cavities.
24.	<u>Mimosa kauki</u>	Groups.	Few prisms.	---	Ranunculaceous.	Unicellular 140- 360 $\mu$ long mainly two armed.	Few laticiferous elements.
25.	<u>Datura metel</u>		Few prisms.	---	Cruciferous	Multicellular 160 -200 $\mu$ .	---
26.	<u>Grewia micrococ.</u>	Groups.	Prisms & clusters.	Many.	---	Few unicellular 150 $\mu$ long.	Radiate shaped trichomes.
27.	<u>Lantana camara</u>	---	Few clusters.	---	Ranunculaceous.	Unicellular 90 - 280 $\mu$ long.	Occasional peltate trichomes & few hairs with crystals in the cells surrounding their bases.
28.	<u>Cymbopogon citratus</u>	Groups.	---	Abundant.	---	---	Oil glands of 20 - 30 $\mu$ dia- meter, large parenchymatous cells of 50 $\mu$ breadth and 120 $\mu$ long.

T A B L E - 6

## MICROSCOPIC CHARACTERS OF POWDERED BARKS

S.No.	Name of the drug	Fibre	Calcium oxalate	Stone cell	Starch grain	Special features.
1	2	3	4	5	6	7
1.	<u>Spondius pinnata</u>	Few groups.	Few prisms.	Abundant isolated of 40 $\mu$ diameter groups of 6 - 8 components.	Scanty.	—
2.	<u>Annona squamosa</u>	Scanty upto 640 $\mu$ long.	Prominent needle shaped crystal 40 - 70 $\mu$ long.	Few in groups. Individual upto 50 $\mu$ diameter.	—	—
3.	<u>Polyalthia fraxana</u>	Few groups & isolated of 480 - 730 $\mu$ long.	—	Few groups.	—	—
4.	<u>Holarrhena antidyenterica</u>	—	Few prisms.	Rectangular stone cells in groups, isolated of 60 $\mu$ length & 20 $\mu$ breadth.	—	—
5.	<u>Oroxylum indicum</u>	Isolated abundant of 200 - 630 $\mu$ long. Few groups.	—	Abundant of 140 $\mu$ length & 50 $\mu$ wide. Groups few of 4 - 6 components.	—	—
6.	<u>Croton oblongifolius</u>	Few groups.	Few prisms.	—	Few	Few oil cells.
7.	<u>Ricinus communis</u>	Few groups.	—	Few isolated 60 $\mu$ long & 30 $\mu$ wide. Also in groups.	—	—
8.	<u>Hydnocarpus wightiana</u>	Few upto 220 $\mu$ long & 30 $\mu$ wide.	Abundant clusters and few prisms.	Few isolated 60 $\mu$ long.	—	—

Table-6 continued...

1	2	3	4	5	6	7
9.	<u>Maohilus macrantha</u>	Many 350-620 $\mu$ long & 50 $\mu$ wide.	—	—	Scanty	—
10.	<u>Pterocarpus marsupium</u>	Few upto 340 $\mu$ long.	Abundant prisms.	Many isolated 40-100 $\mu$ length & 30 $\mu$ width.	Few	Brownish red iso-diametric cells of 50 $\mu$ breadth & 70 $\mu$ length.
11.	<u>Tamarindus indica</u>	Few groups.	Few prisms.	Few in groups.	Many	—
12.	<u>Cassia fistula</u>	Isolated upto 240 $\mu$ long.	—	—	Many	—
13.	<u>Moringa</u> <u>Pteryocarpus</u>	Few upto 760 $\mu$ long.	Many clusters & prisms.	Few upto 30 $\mu$ wide & 80 $\mu$ long.	Few	—
14.	<u>Eucalyptus globulus</u>	Isolated few of 640 $\mu$ long 7 20 $\mu$ wide.	Double type prisms of 30 $\mu$ long. Many.	—	—	—
15.	<u>Careya arborea</u>	Isolated, few of 200 $\mu$ long.	Abundant prisms, upto 50 $\mu$ long.	Few, subrectangular, thickened on inner and radial walls about 50 $\mu$ long.	—	Brownish glands, abundant, oval 40 $\mu$ diameter.
16.	<u>Nyctanthes arbor-tristis</u>	—	—	Many groups of 2 component of 40 $\mu$ breadth & 65 $\mu$ length.	Few	Masses of lignified cells of 100-245 $\mu$ diameter.
17.	<u>Zizyphus rugosa</u>	Few isolated upto 140 $\mu$ long.	Few.	Few groups.	Few	—

Table-6 continued...

1	2	3	4	5	6	7
18.	<u>Zizyphus jujuba</u>	Few groups.	Abundant prisms.	Groups of 2-4 components.	Few.	---
19.	<u>Psychotria truncata</u>	Few of 640 $\mu$ long.	Abundant prisms of 40 $\mu$ long.	Abundant rectangular, isolated 40 $\mu$ wide, 60 $\mu$ long.	Abundant.	---
20.	<u>Zanthoxylum rhetsa</u>	Few isolated upto 160 $\mu$ long.	Few prisms.	Few oval of 15 $\mu$ wide & 20 $\mu$ long.	---	Lignified polygonal shaped cells in groups.
21.	<u>Allophylus cobbe</u>	Few 370 $\mu$ long.	Few prisms.	---	---	---
22.	<u>Mimusops elengi</u>	Abundant isolated of 140-420 $\mu$ long few groups.	Few prisms.	Isolated, many of 30 $\mu$ diameter, groups of 3-4 components, few.	---	---
23.	<u>Helicteres isora</u>	Few groups.	Many clusters crystals.	Isolated few groups of 2 - 3 components.	Few.	Idioblast.
24.	<u>Sterculia urens</u>	Groups, few.	Many clusters crystals.	Isolated of 80 $\mu$ long groups of 4-5 components.	---	---
25.	<u>Grewia micrococca</u>	Isolated & groups. Individual of 20 $\mu$ wide & 440 $\mu$ long.	---	---	Abundant.	---
26.	<u>Ficus bengalensis</u>	---	Abundant prisms.	Abundant, subrectangular about 60-80 $\mu$ long.	---	Few rectangular lignified structures 20-80 $\mu$ long.

Table-6 continued...

1	2	3	4	5	6	7
27.	<u>Vitex negunda</u>	Few of 30 $\mu$ wide & 210 $\mu$ long.	Clusters crystals.	Isolated few rectangular 30 $\mu$ wide & 70 $\mu$ long.	—	—
28.	<u>Gmelina arborea</u>	—	Few prisms.	Isolated oval 50-80 $\mu$ diameter, groups of 2-6 components.	Few.	Polygonal shaped lignified cells.

CHAPTER V  
CHEMOTAXONOMICAL STUDIES OF THE  
MEDICINAL PLANTS

CHAPTER VCHEMOTAXONOMICAL STUDIES OF THE MEDICINAL PLANTSTLC PATTERN OF METHANOLIC EXTRACT OF THE DRUG USING EIGHT DEVELOPING SOLVENTS FOR PHENOLIC PLANT CONSTITUENTS

The methods which have been used for morphological and anatomical drug comparison can yield valuable information concerning the plant or animal origin but not about the nature and amount of the active substances. Moreover the drug may be present as an extract and microscopic analysis fails with such conditions of the drugs. Apart from amino acids, nucleic acids and sugars, plants contain numerous other hydrophilic constituents. Plant phenol derivatives embrace a wide range of hydrophilic plant substances which possess in common an aromatic ring, bearing one or more hydroxyl constituents. These are secondary products of metabolism important in medicine and therefore they can be utilised to characterise a plant chemically. As a rule, when the drug extracts are allowed to run in a developing solvent of the choice, their chemical constituents run along with the mobile phase and as a result they show some significant spot areas, when viewed under UV or sprayed with the appropriate spraying reagents on the developed chromatograms. The colour spots and their R<sub>f</sub> values can be made use as Markers for the identification of the plant products.

Considering this fact, thin layer chromatography (TLC) was utilised to drug identification making use of different solvent composition with respect to mobility of compound classes of phenol derivatives. The compounds moved on the TLC plates showed different colour spots in UV as well as when sprayed with chro-

mogenic agents. These spots when noted for their Rf values and colour revealed a good technique for the identification of plant products and hence this TLC analytical tool helped in monitoring plant samples based on finger print technique.

Table - 7 gives the results of Rf values and colour of the spots for different root samples in methanolic extract.

Table - 8 gives the results of Rf values and colour of the spots for different seed samples in methanolic extract.

Table-9 gives the results of Rf values and colour of the spots for different leaf samples in methanolic extract.

Table-10 gives the result of Rf values and colour of the spots for different bark samples in methanolic extract.

The solvent systems mentioned in the tables are described in Chapter II under materials and methods.

TLC PATTERN OF METHANOLIC EXTRACT OF  
THE DRUGS USING EIGHT DEVELOPING  
SOLVENTS FOR PHENOLIC PLANT  
CONSTITUENTS.

T A B L E - 1

THIN LAYER CHROMATOGRAPHIC STUDY OF ROOT EXTRACTS

S.No.	Name of the drug	Solvent system	UV	I <sub>2</sub>	Anisaldehyde	AlCl <sub>3</sub>	AnIIIcl <sub>3</sub>	KOH	Lead acetate	FeCl <sub>3</sub>	Folin ciocalteu
			Rf.Colour	Rf.	Rf.Colour	Rf.Colour	Rf.Colour	Rf.Colour	Rf.Colour	Rf.Colour	Rf.Colour
1	2	3	4	5	6	7	8	9	10	11	12
1.	<u>Adhatoda vasica</u>	I	-	-	-	-	-	-	-	-	-
		II	0.45 B1	0.42	-	-	-	-	-	-	-
		III	-	0.05	-	-	-	-	-	-	-
		IV	-	0.10	-	-	-	0.10 UB1	-	-	-
		V	0.70 B1 0.80 Gr 0.90 R	0.67 0.82 0.90	-	-	-	-	-	-	-
		VI	0.85 RoB1	0.65 0.75 0.85	-	-	-	-	-	-	-
		VII	-	-	-	-	-	-	-	-	-
		VIII	-	-	-	-	-	-	-	-	-
2.	<u>Hemidesmus indicus</u>	I	0.70 RoB1	0.42	-	0.65 B1	-	-	-	-	-
		II	0.70 RoB1	0.09 0.70	-	0.75 B1	0.70 New phiroji	-	-	-	-
		III	0.65 dB1	0.65	-	-	-	-	-	-	-
		IV	0.70 dB1	0.70	-	-	-	-	-	-	-
		V	-	-	-	-	-	-	-	-	-
		VI	-	0.70	-	0.70 B1	-	-	-	0.70 B1	0.68 Gr
		VII	-	-	-	-	-	-	-	-	-
		VIII	0.27 O	0.45	-	-	-	-	-	-	-
3.	<u>Rauwolfia serpentina</u>	I	-	0.02 0.13 0.26	-	-	-	-	-	-	-
		II	-	0.02 0.13	-	-	-	-	-	-	-
		III	0.97 B1	0.10 0.61 0.99	-	0.10 YG 0.60 YG	-	-	-	-	-

Table-7 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		IV	0-0.36 Bl. run	0.40 0.60	-	-	-	-	-	-	-
		V	0-0.5 Gr run	0.03 0.16 0.34 0.50	-	-	0.03 RoBl	0.18 RoBl	-	-	-
		VI	0.03 Bl 0.80 RoBl 0.94 Gr	0.03 0.03 0.76 0.80 0.93	-	-	0.76 RoBl	-	-	-	-
		VII	-	0.73 0.76 0.80	-	0.73 Bl 0.80 RoBl	-	0.76 Bl 0.80 RoBl	0.75 Bl 0.80 RoBl	-	-
		VIII	0.80 RoBl run 0.70 RoBl 0.85 RoBl 0.90 Gr	0.12 0.20 0.63 0.80	-	0.20 RoBl 0.65 RoBl 0.80 RoBl	-	-	-	-	-
4.	<u>Capparis zeylanica</u>	I	0.20 Bl	0.20	-	-	-	-	-	-	-
		II	-	0.65	-	0.68 Y	-	-	-	-	-
		III	-	0.70 0.84	-	-	0.70 Bl	-	-	-	-
		IV	-	-	-	-	-	-	-	-	-
		V	-	0.65 0.68	-	-	-	-	-	-	-
		VI	-	0.22 0.45	-	-	-	-	-	-	-
		VII	-	0.16 0.92	-	-	-	-	-	-	-
		VIII	0.35 Bl	0.33 0.56	-	-	-	-	-	-	-
5.	<u>Viburnum foetidum</u>	I	0.17 Bl 0.70 Bl	0.15 0.65	-	-	-	-	-	-	-

Table-7 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		II	0.45 B1 0.75 B1	0.32 0.45 0.75	-	-	-	-	-	-	-
		III	0.63 B1 0.92 B1	0.15 0.62 0.90	-	-	-	-	-	-	-
		IV	-	-	-	-	-	-	-	-	-
		V	0.82 B1 0.88 B1	0.80 0.88	-	-	-	0.82 B1	-	0.80 R 0.88 R	0.80 B1 0.88 B1
		VI	-	-	-	-	-	-	-	-	-
		VII	-	-	-	-	-	-	-	-	-
		VIII	0.90 Y	0.70 0.80	-	-	-	-	-	-	-
6.	<u>Momordica dioica</u>	I	0.70 B1	0.70 0.80	-	0.70 B1	-	-	0.70 B1	-	-
		II	-	-	-	-	-	-	-	-	-
		III	-	-	-	-	-	-	-	-	-
		IV	-	-	-	-	-	-	-	-	-
		V	-	-	-	-	-	-	-	-	-
		VI	-	-	-	-	-	-	-	-	-
		VII	-	-	-	-	-	-	-	-	-
		VIII	0.90 Y	0.85	-	-	-	-	-	-	-
7.	<u>Croton oblongifolius</u>	I	-	-	-	-	-	-	-	-	-
		II	-	-	-	-	-	-	-	-	-
		III	-	0.57	-	-	-	-	-	-	-
		IV	-	-	-	-	-	-	-	-	-
		V	-	0.04	-	-	0.03 B1	-	-	-	-
		VI	-	0.04	-	-	0.04 UB1	-	-	-	-

Table-7 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		VII	-	0.70 0.90	-	-	-	0.90 RoBl	-	-	-
		VIII	0.80 RoBl	0.40 0.50 0.70 0.82	-	0.40 RoBl 0.80 RoBl	-	0.50 RoBl 0.70 RoBl	-	-	-
8.	<u>Casearea esculenta</u>	I	0.04 Y 0.20 Bl	0.06 0.22	-	-	-	-	-	-	-
		II	0.10 R 0.25 R 0.55 R	0.26 0.45 0.60	-	0.28 Gr 0.60 Gr	-	-	-	-	-
		III	0.30 Gr 0.60 Gr	0.10 0.32 0.62	-	0.10 Bl 0.32 lBl 0.60 lBl	0.60 Bl	0.10 Bl 0.35 Bl 0.60 Bl	-	-	-
		IV	-	-	-	-	-	-	-	-	-
		V	0.47 Bl 0.63 Bl	0.05 0.40 0.45 0.62	-	0.05 Aq 0.45 Bl 0.40 Bl 0.62 Bl	0.45 YGr 0.50 YGr	-	-	0.45 V 0.62 V	0.45 Bl
		VI	0.75 Bl	0.60 0.70	-	0.65 lBl 0.75 lBl	-	-	-	-	-
		VII	0.60 Bl	0.50 0.60	-	0.50 Gr 0.60 Gr	-	0.53 Y	0.53 Gr	-	0.68 YGr
		VIII	0.40 GY 0.70 GY	0.30 0.40 0.70	-	0.30 Aq	-	-	-	-	-
9.	<u>Arundinella gigantea</u>	I	0.18 V	0.15 0.23 0.73	-	-	-	0.80 Bl	0.68 Bl	-	-
		II	-	0.58 0.68	-	0.68 Bl	-	-	-	-	-
		III	0.60 R	0.58	-	-	0.60 VBl	0.60 Bl	0.60 Bl	-	-
		IV	0.57 R	0.55	-	0.60 UBl	0.60 UBl	0.60 UBl	0.60 Bl	-	-
		V	0.07 New Phiroji 0.57 Bl	0.04 0.58	-	-	-	-	-	-	-

Table-7 continued...

1	2	3	4	5	6	7	8	9	10	11	12	
		VI	0.10 dB1 0.60 dB1	0.10 0.60 0.72	-	0.62 dB1 0.72 dB1	0.60 UB1 0.70 UB1	-	7	-	-	-
		VII	0.95 New phiroji	0.36 0.95	-	-	0.95 B1	-	-	-	-	-
		VIII	0.42 B1 0.73 B1	0.42 0.73 0.89	-	-	0.85 V	-	-	-	-	-
10.	<u>Leucas aspera</u>	I	0.17 Gr	0.15 0.32	-	-	-	-	0.15 B1	0.18 B1	-	-
		II	0.52 Gr	0.42 0.55	-	0.48 B1	0.50 G	-	-	-	-	-
		III	0.78 Gr	0.12 0.68 0.85	0.10 V 0.85 V	-	0.65 GrB1	-	-	-	-	-
		IV	0.67 Gr	0.35 0.50 0.58 0.75	-	0.26 B1	0.62 New phiroji	0.23 lGr 0.49 Gr	0.27 UB1	-	0.47 B1	-
		V	0.55 Gr 0.74 Gr 0.80 Gr	0.17 0.40 0.70 0.82	0.40 Gr	0.75 Gr	0.36 B1 0.40 B1 0.70 B1	0.68 G	0.10 B1 0.45 B1	-	-	-
		VI	0.64 Gr 0.82 Gr	0.64 0.85	0.70 B1	0.60 Gr 0.80 Gr	0.69 0	-	-	-	0.35 B1 0.51 B1	-
		VII	0.79 Gr 0.85 Gr 0.90 Gr	0.30 0.47 0.82 0.90	-	0.92 d0	0.85 d0	0.45 Y	0.14 B1 0.30 UB1 0.50 UB1 0.82 V	-	-	-
		VIII	0.19 YB1 0.45 UB1 0.72 10	0.55 0.70	0.50 V 0.65 V	0.19 Y	-	0.70 B1	-	-	-	-
11.	<u>Pterocarpus marsupium</u>	I	0.25 V	0.13 0.45 0.73	-	-	-	-	0.71 B1	-	-	-

Table-7 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		II	0.52 V	0.10 0.52 0.65	-	0.65 UB1	0.60 B1	0.63 B1	0.60 B1	-	-
		III	0.58 V	0.62 0.75	-	0.60 UB1	0.75 UB1	0.62 B1	0.62 B1	-	-
		IV	0.60 Gr	0.60	-	-	-	-	-	-	-
		V	-	-	-	-	-	-	-	-	0.55 B1
		VI	0.05 V	0.06 0.47 0.60 0.78	-	0.79 1B1	-	-	0.78 B1	0.80 R	0.78 B1
		VII	-	0.7	-	0.7 B1	-	0.7 B1	0.7 B1	-	-
		VIII	0.42 V 0.68 V	0.35 0.45 0.68	-	-	-	-	0.60 Y 0.65 Y	-	-
12. <u>Coesalpinea crista</u>		I	-	-	-	-	-	-	-	-	-
		II	-	-	-	-	-	-	-	-	-
		III	-	-	-	-	-	-	-	-	-
		IV	-	-	-	-	-	-	-	-	-
		V	0-0.40 Bl. run	0.33 0.40	-	-	-	0-0.40 Gr. run 0.42 Gr.	-	0.42 B1	0.42 B1
		VI	-	-	-	-	-	-	-	-	-
		VII	-	0.65 0.90	-	-	-	0.90 B1	-	-	0.90 B1
		VIII	-	0.90	-	-	-	0.85 B1	-	-	0.88 B1
13. <u>Asparagus racemosus</u>		I	-	0.23 0.57	-	-	-	-	-	-	-
		II	-	0.30 0.55	-	-	-	-	-	-	-
		III	-	-	-	-	-	-	-	-	-

Table-7 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		IV	-	-	-	-	-	-	-	-	-
		V	-	0.30 0.38	-	-	-	-	0.03 B1.run 0.35 B1	-	-
		VI	-	0.42	-	-	-	-	0.42 B1	-	-
		VII	-	-	-	-	-	-	-	-	-
		VIII	-	-	-	-	-	-	-	-	-
14.	<u>Smilax macrophylla</u>	I	-	0.52	-	-	-	-	-	-	-
		II	-	0.54	-	-	-	-	-	-	-
		III	-	-	-	-	-	-	-	-	-
		IV	-	-	-	-	-	-	-	-	-
		V	-	0.48	-	-	-	-	-	-	-
		VI	-	0.40	-	-	-	-	-	-	-
		VII	-	-	-	-	-	-	-	-	-
		VIII	-	-	-	-	-	-	-	-	-
15.	<u>Stephania hernandifolia</u>	I	0.15 B1 0.70 B1	0.08 0.12 0.72	-	-	-	-	-	-	-
		II	-	-	-	-	-	-	-	-	-
		III	-	0.10 0.15	-	-	-	-	-	-	-
		IV	-	0.85	-	-	-	-	-	-	-
		V	-	0.85	-	-	-	-	-	-	-
		VI	0.18 B1	0.15 0.40	-	-	-	-	-	-	-
		VII	0.45 B1	0.45	-	-	-	-	-	-	-
		VIII	0.47 B1 0.90 B1	0.27 0.45 0.90	-	-	-	-	-	-	-

Table-7 continued...

1	2	3	4	5	6	7	8	9	10	11	12
16.	<u>Tinospora cordifolia</u>	I	-	-	-	-	-	-	-	-	-
		II	-	0.45	-	-	-	-	-	-	-
		III	-	0.80	-	-	-	-	-	-	-
		IV	-	-	-	-	-	-	-	-	-
		V	-	0.60	-	-	-	-	-	-	-
		VI	-	0.32 0.58	-	-	-	-	-	-	-
		VII	0-0.9 Gr. run	0.30 0.90	-	0.30 Y	-	-	-	-	-
		VIII	0.65 B1	0.28 0.65 0.90	-	0.25 Y	0.27 Mag.	-	-	-	-
17.	<u>Cocculus macrocarpus</u>	I	0.70 B1	0.99 0.70	-	-	-	-	-	-	-
		II	0.70 B1	0.70	-	-	-	-	-	-	-
		III	0.65 B1	0.62	-	-	-	-	-	-	-
		IV	0.70 B1	0.70	-	-	-	-	-	-	-
		V	0.90 B1	0.70	-	-	-	-	-	0.70 R	0.70 B1
		VI	0.85 B1	0.85	-	-	-	-	-	0.85 R	0.85 B1
		VII	0.99 B1	0.95	-	-	-	-	-	-	-
		VIII	0.90 B1	0.90	-	-	-	-	-	-	-
18.	<u>Maesa indica</u>	I	-	-	-	-	-	-	-	-	

Table-7 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		II	-	0.60	-	-	-	-	-	-	-
		III	-	-	-	-	-	-	-	-	-
		IV	-	-	-	-	-	-	-	-	-
		V	0.10 B1	0.10 0.16	-	0.15 B1	-	0.15 B1	-	-	0.15 B1
		VI	-	0.96	-	-	-	-	-	-	-
		VII	0.5 RoB1	0.5 0.88	-	0.50 B1 0.88 YG	-	0.50 B1	0.88 RoB1	-	-
		VIII	0.98 RoB1	0.44 0.50 0.60 0.95	-	-	-	0.40 RoB1 0.50 RoB1 0.60 RoB1	-	-	-
19.	<u>Conoclinium wheedii</u>	I	-	-	-	-	-	-	-	-	-
		II	-	-	-	-	-	-	-	-	-
		III	-	-	-	-	-	-	-	-	-
		IV	-	-	-	-	-	-	-	-	-
		V	-	-	-	-	-	-	-	-	-
		VI	-	-	-	-	-	-	-	-	-
		VII	-	-	-	-	-	-	-	-	-
		VIII	0.90 B1	0.85 0.90	-	-	-	-	-	-	-
20.	<u>Ixora parviflora</u>	I	0.2 B1	0.20	-	-	-	-	-	-	-

Table-7 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		II	0.6 B1	0.54 0.62	-	-	-	-	-	-	-
		III	0.9 B1	0.82 0.90	-	-	-	-	-	-	-
		IV	-	-	-	-	-	-	-	-	-
		V	0.35 B1	0.28 0.35	0.30 V	-	-	-	-	-	-
		VI	0.20 B1	0.20 0.78	-	-	-	-	-	0.20 V 0.75 V	0.20 B1 0.75 B1
		VII	0.95 B1	0.90	-	0.90 YG	-	0.92 B1	0.90 B1	-	-
		VIII	0.65 B1	0.65	-	-	-	-	-	-	-
21.	<u>Fuederia foetida</u>	I	0.2 B1	0.32 0.20 0.47	-	-	-	-	-	-	-
		II	0.6 B1	0.6	-	-	-	-	-	-	-
		III	0.9 B1	0.42 0.9	-	-	-	-	-	-	-
		IV	0.7-	0.74	-	-	-	0.72 B1	-	-	0.72 B1
		V	-	-	-	-	-	-	-	-	-
		VI	-	0.78	-	-	-	-	-	-	-
		VII	0.95 B1	0.90	-	-	-	-	-	-	-
		VIII	0.70 B1	0.45 0.72	-	-	-	-	-	-	-
22.	<u>Glycosmis pentaphylla</u>	I	0.25 V	0.10 0.50	-	-	-	-	-	-	-
		II	0.25 VB1 0.65 Gr	0.20 0.32 0.60	-	0.32 B1 0.63 Y	-	0.60 Gr	-	-	-

Table-7 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		III	-	0.60	-	0.45 B1 0.55 B1 0.62 B1	-	-	-	-	-
		IV	-	-	-	-	-	-	-	-	-
		V	-	-	-	-	-	-	-	-	-
		VI	-	-	-	-	-	-	-	-	-
		VII	-	-	-	-	-	-	-	-	-
		VIII	-	-	-	-	-	-	-	-	-
23.	<u>Citrus medica</u>	I	0.37 B1 0.40 B1 0.70 B1	0.07 0.40 0.52 0.68	-	0.80 B1.run	0.40 RoB1 0.70 RoB1	-	0.40 B1 0.70 B1	-	0.45 Gr 0.65 Gr
		II	0.30 B1 0.70 RoB1	0.42 0.70	-	0.68 RoB1	0.40 R 0.70 R	-	0.68 B1	-	0.40 Gr
		III	0-0.7 RoB1. run 0.40 Buff 0.65 RoB1	0.45 0.65	-	0.35 UB1 0.70 UB1	-	0.05 B1 0.30 B1 0.40 B1 0.70 B1	-	-	0.35 B1 0.65 B1
		IV	0.35 B1 0.45 B1 0.75 B1	0.65 0.70 0.88	-	0.30 UB1 0.70 UB1	-	-	-	-	0.90 B1
		V	0.70 B1 0.80 B1 0.90 B1	0.67 0.80 0.90	-	0.70 B1 0.80 B1 0.90 B1	-	-	-	0.70 B1 0.80 B1	0.70 B1 0.80 B1
		VI	0.85 RB1	0.85	-	0.85 B1	-	-	-	-	-
		VII	0.93 B1	0.98	-	-	-	-	-	-	-
		VIII	0.80 B1 0.90 B1	0.74 0.80 0.90	-	-	-	-	-	-	-

Table-7 continued...

1	2	3	4	5	6	7	8	9	10	11	12
24.	<u>Lygodium flexuosum</u>	I	0.70 RoB1	0.09 0.40 0.68	-	0.75 B1	0.70 RoB1	-	-	-	-
		II	0.50 RoB1 0.70 RoB1	0.42 0.70	-	0.70 B1	0.70 RoB1	-	-	-	-
		III	0.65 RoB1	0.65	-	-	-	-	-	-	-
		IV	0.75 B1	0.75	-	-	-	-	-	-	-
		V	0.90 VB1	0.85 0.90	-	-	-	-	-	-	-
		VI	-	-	-	-	-	-	-	-	-
		VII	-	0.75	-	-	-	0.73 B1	-	0.72 R	-
		VIII	0.90 RoB1	0.90	-	-	-	-	-	-	-
25.	<u>Grewia microcos</u>	I	0.2 B1	0.1 0.20 0.32	-	-	-	-	-	-	-
		II	0.6 B1	0.35 0.60	-	-	-	-	-	-	-
		III	0.9 B1	0.35 0.90	-	-	-	-	-	-	-
		IV	0.88 B1	0.32 0.45 0.88	-	-	-	0.88 Y	-	-	-
		V	-	-	-	-	-	-	-	-	-
		VI	-	-	-	-	-	-	-	†	-
		VII	-	-	-	-	-	-	-	-	-
		VIII	0.95 B1	0.95	-	-	-	-	-	-	-

Table-7 continued...

1	2	3	4	5	6	7	8	9	10	11	12
26.	<u>Vitex negundo</u>	I	-	-	-	-	-	-	-	0.22 B1	-
		II	-	0.10 0.33 0.25 0.72	0.13 Gr 0.76 V	-	-	-	-	0.33 P	0.20 B1
		III	-	0.40 0.85	-	-	-	-	-	-	-
		IV	0.60 Gr	0.65	-	-	-	-	-	-	-
		V	0.58 Gr 0.74 Gr	0.60 0.75	-	-	-	-	-	0.58 P	0.58 B1
		VI	-	0.50 0.63	-	-	-	-	-	-	-
		VII	0.90 V	0.30 0.54 0.85	-	0.52 B1	-	0.54 B1	0.29 UB1 0.54 UB1	-	-
		VIII	-	0.55 0.70	-	-	-	-	-	-	-
27.	<u>Curcuma zedoaria</u>	I	0.10 B1	-	-	-	-	-	-	-	-
		II	-	0.10 0.25 0.30 0.65	-	-	0.25 dG 0.30 Y	-	0.10 Y 0.20 Buff	-	-
		III	0.15 B1 0.35 B1 0.55 B1	0.10 0.15 0.28 0.35 0.50	-	-	-	-	0.17 B1 0.20 Y 0.50 Buff	0.38 G 0.50 G 0.63 G	-
		IV	0.30 B1 0.35 B1 0.45 B1	0.30 0.38 0.42 0.54	-	-	-	0.50 RoB1	0.30 Y 0.45 Y	0.50 G	-

Table-7 continued.....

1	2	3	4	5	6	7	8	9	10	11	12
		V	0.52 YG 0.68	0.52 0.68	-	-	-	-	-	0.55 B1	0.55 B1
		VI	0.60 dG 0.62 Buff	0.60 0.65	-	-	-	-	-	0.60 B1	0.60 B1
		VII	0.80 B1	0.42 0.65 0.82	-	0.80 Y	-	-	0.80 Y	-	-
		VIII	0.97 B1	0.95	-	-	-	-	-	-	-
28.	<u>Knempferia rotunda</u>	I	0.2 B1	0.10 0.20	-	-	-	-	-	-	-
		II	0.6 B1	0.55 0.60 0.90	-	0.6 Y 0.9 Y	-	-	-	-	-
		III	0.9 B1	0.88	-	-	-	-	-	-	-
		IV	-	-	-	-	-	-	-	-	-
		V	-	0.65	-	-	-	-	-	-	-
		VI	-	0.37	-	-	-	-	-	-	-
		VII	-	-	-	-	-	-	-	-	-
		VIII	0.95 B1	0.93	-	-	-	-	-	-	-

T A B L E - 8  
THIN LAYER CHROMATOGRAPHIC STUDY OF SEED EXTRACTS

S.No.	Name of the drug	Solvent system	UV	I <sub>2</sub>	Anisaldehyde	AlCl <sub>3</sub>	AnIIIcl <sub>3</sub>	KoH	Lead acetate	Fecl <sub>3</sub>	Folin ciocalteu
			Rf.Colour	Rf	Rf.Colour	Rf.Colour	Rf.Colour	Rf.Colour	Rf.Colour	Rf.Colour	Rf.Colour
1	2	3	4	5	6	7	8	9	10	11	12
1.	<u>Ricinus communis</u>	I	0.2 Bl	0.2	-	-	-	-	-	-	-
		II	0.8 Bl	0.6 0.9	-	-	-	-	-	-	-
		III	0.90 Bl	-	-	-	-	-	-	-	-
		IV	0.65 Bl	-	-	-	-	-	-	-	-
		V	0.85 Bl	-	-	-	-	-	-	-	-
		VI	0.90 Bl	0.40 0.70 0.90	-	-	-	-	-	-	-
		VII	-	-	-	-	-	-	-	-	-
		VIII	0.95 Bl	-	-	-	-	-	-	-	-
2.	<u>Hydnocarpus wightiana</u>	I	-	-	-	-	-	-	-	-	-
		II	-	-	-	-	-	-	-	-	-
		III	-	0.85	-	-	-	-	-	-	-
		IV	0.65 Bl	0.45 0.65	-	-	-	-	-	-	-
		V	-	-	-	-	-	-	-	-	-
		VI	0.50 Gr 0.90 Gr	0.50 0.90	-	-	-	-	-	-	-
		VII	-	-	-	-	-	-	-	-	-
		VIII	0.9 Gr	0.9	-	-	-	-	-	-	-

Contd...

Table-8 continued...

1	2	3	4	5	6	7	8	9	10	11	12
3.	<u>Cassia tora</u>	I	-	0.40 0.70 0.95	-	-	0.99 Y0	-	-	-	-
		II	0.80 P <sub>Ro</sub>	0.80	-	-	0.82 V	-	-	-	-
		III	0.94 Buff	0.30 0.96	-	0.96 P <sub>Ro</sub>	-	-	-	-	-
		IV	0.95 P <sub>Ro</sub>	0.62 0.85 0.92	-	0-0.33 P <sub>Ro</sub> run 0.35 P <sub>Ro</sub> 0.95 P <sub>Ro</sub>	-	0.96 V	-	-	-
		V	0.90 P <sub>Ro</sub>	0.40 0.60 0.90	0.90 P <sub>Ro</sub>	0.90 P <sub>Ro</sub>	-	0.56 V	-	-	-
		VI	-	0.35 0.50 0.70 0.85	-	0.30 P <sub>Ro</sub> 0.85 P <sub>Ro</sub>	-	-	-	-	-
		VII	-	-	-	-	-	-	-	-	-
		VIII	0.97 d0	0.80 0.90	0.78 P <sub>Ro</sub>	0.20 B1 0.45 B1 0.58 B1 0.78 B1 0.93 B1	0.25 RoB1 0.32 P	-	-	-	-
4.	<u>Strychnos nux-vomica</u>	I	0.1 B1	0.1	-	-	-	-	-	-	-
		II	0.2 B1	0.2	-	-	-	-	-	-	-
		III	0.8 B1	0.8	-	-	-	-	-	-	-
		IV	0.7 B1	0.7	-	-	-	-	-	-	-
		V	0.90 B1	0.80	-	-	-	-	-	-	-
		VI	0.90 RoB1	0.90	-	-	-	-	-	-	-
		VII	-	0.25	-	-	-	-	-	-	-
		VIII	0.98 B1	0.95	-	-	-	-	-	-	-

T A B L E - 9  
THIN LAYER CHROMATOGRAPHIC STUDY OF LEAF EXTRACTS

S.No.	Name of the drug	Solvent system	UV	I <sub>2</sub>	Anisaldehyde	AlCl <sub>3</sub>	AniIICl <sub>3</sub>	KOH	Lead acetate	FeCl <sub>3</sub>	Folin ciocalteu
			Rf. Colour	Rf.	Rf. Colour	Rf. Colour	Rf. Colour	Rf. Colour	Rf. Colour	Rf. Colour	Rf. Colour
1	2	3	4	5	6	7	8	9	10	11	12
1. <u>Adhatoda vasica</u>	I		0.10 BL	0.10	-	0.02 Bl	-	-	-	-	-
	II		-	0.55 0.60 0.88	-	0.90 Gr	-	-	-	-	-
	III		0.99 C	0.55 0.98	-	0.95 Bl	0.99 YO	-	-	-	0.53 Gr
	IV		0.30 C	0.30 0.95	-	0.32 Bl	0.93 YO	0.95 Bl	-	-	0.50 Gr
	V		-	0.05 0.38	-	-	-	-	-	-	0.04 Gr 0.35 Gr
	VI		0.94 C	0.10 0.80 0.94	-	-	-	0.90 Bl	-	-	0.10 Gr 0.80 Gr
	VII		-	-	-	-	-	-	-	-	-
	VIII		0.93 Bl	0.90	-	-	-	-	-	-	-
2. <u>Andrographis paniculata</u>	I		0.1 Bl	0.1	-	-	-	-	-	-	-
	II		0.2 Bl	0.2	-	-	-	-	-	-	-
	III		0.7 Bl 0.8 Bl	0.7 0.8	-	-	-	-	-	-	-
	IV		0.2 Bl	0.2	-	-	-	-	-	-	-
	V		-	-	-	-	-	-	-	-	-
	VI		0.40 Bl	0.38	-	-	-	-	-	-	-
	VII		0.98 Bl	0.98	-	-	-	-	-	-	-
	VIII		0.98 Bl	0.98	-	-	-	-	-	-	-
3. <u>Annona squamosa</u>	I		0.60 Bl	0.05 0.55 0.60	-	0.52 Bl	0.05 YO	-	-	-	-
	II		0.80 Bl	0.18 0.30 0.85	-	0.20 BlG 0.30 BlG	0.80 YO	-	-	-	-

Table-9 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		III	0.34 Bl 0.36 Gr 0.98 Gr	0.34 0.98	-	-	-	-	0.30 0	-	-
		IV	0-0.85 Buff run	0.87	-	-	0.87 YO	0.87 Bl	0.87 0	-	-
		V	0.50 G 0.98 G	0.50 0.96	-	-	0.96 YO	-	0.96 0	-	-
		VI	0.40 G 0.50 G	0.40 0.50	-	-	-	-	-	-	-
		VII	-	-	-	-	-	-	-	-	-
		VIII	-	-	-	-	-	-	-	-	-
4.	<u>Calotropis gigantea</u>	I	-	0.25 0.57 0.90	-	-	-	-	-	-	-
		II	-	0.13 0.30 0.55	-	-	-	-	-	-	-
		III	-	-	-	-	-	-	-	-	-
		IV	0.70 Bl	0.72	-	-	-	0.72 R	-	-	-
		V	-	0.62 0.75	-	-	-	-	-	0.65 Bl	0.62 1Bl
		VI	-	-	-	-	-	-	-	-	-
		VII	-	-	-	-	-	-	-	-	-
		VIII	-	-	-	-	-	-	-	-	-
5.	<u>Croton oblongifolius</u>	I	-	0.25	-	-	-	-	-	-	-
		II	-	0.65 0.90	-	-	-	-	-	-	-
		II	-	0.28 0.55 0.70	-	-	-	-	-	-	-
		III	-	0.70	-	-	-	-	-	-	-
		IV	-	-	-	-	-	-	-	-	-
		V	-	0.85	-	-	-	-	-	0.85 G	-
		VI	0.80 BlG	0.82	-	-	-	-	-	0.82 G	-
		VII	-	-	-	-	-	-	-	-	-
		VIII	0.80 TGr	-	-	-	-	-	-	-	-

Contd...

Table-9 continued...

1	2	3	4	5	6	7	8	9	10	11	12
6. <u>Ricinus communis</u>	I	0.55 YG	0.55	-	0.52 Bl	-	-	-	-	-	-
	II	0.70 YG	0.70	-	-	0.70 YO	-	-	-	-	-
	III	-	0.10 0.95	-	-	-	0.10 R 0.98 R	-	-	-	-
	IV	0.87 YG	0.86	-	-	-	0.86 R	-	-	-	-
	V	0.88 YG 0.90 YG	0.90	-	-	-	-	-	-	-	-
	VI	0.4 YG 0.5 YG	0.40 0.50	-	-	-	-	-	-	-	-
	VII	-	-	-	-	-	-	-	-	-	-
	VIII	-	-	-	-	-	-	-	-	-	-
7. <u>Leucaena aspera</u>	I	0.02 R	0.05	0.37 Buff	0.10 O	0.05 R	0.05 Bl	-	-	-	
		0.14 R	0.14		0.20 O	0.18 O	0.11 Bl	-	-	-	
		0.22 Bl	0.22								
			0.35								
	II	0.35 G	0.33	0.62 Buff	0.55 R	0.54 O	-	-	-	-	
		0.45 Bl	0.44		0.60 R	0.60 O					
		0.57 Bl	0.52								
		0.65 R	0.65								
	III	0.05 O	0.06	0.85 Bl	0.05 O	0.04 O	0.04 SalP	-	-	-	
		0.81 RoBl	0.81		0.81 O	0.80 O	0.82 Br				
	IV	0.15 O	0.15	-	0.75 Buff	0.70 O	0.60 Gr	-	-	-	
		0.22 O	0.22								
		0.70 O	0.60								
		0.75 O	0.73								
V	0.26 RoBl	0.25	-	0.26 O	0.32 O	-	-	0.32 Bl	0.43 Bl		
	0.32 O	0.30		0.32 lGr				0.45 Bl	0.65 Bl		
	0.46 O	0.45		0.43 lGr							
	0.52 O	0.52		0.53 lGr				0.70 Bl			
	0.60mO	0.70		0.70 O							
VI	0.57 R	0.56	0.57 R	0.65 O	-	-	-	-	-		
	0.67 R	0.66	0.67 Bl								
	0.81 O	0.80									
	0.86 O	0.85									
VII	-	0.38	0.77 R	0.35 Y	0.72 O	-	-	-	-		
		0.55		0.53 Y	0.82 O						
		0.70		0.72 Bl							
		0.80		0.82 O							
		0.95		0.92 O							

Contd...

Table-9 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		VIII	-	0.18 0.40 0.60 0.72	-	0.15 0 0.43 0	0.65 0 0.73 0	-	-	-	-
8.	<u>Pterocarpus marsupium</u>	I	0.24 B1	0.22	-	-	0.22 B1	-	-	-	-
		II	0.92 B1 0.98 B1	0.92 0.98	-	-	-	-	-	-	-
		III	0.97 B1 0.99 B1	0.96 0.98	-	-	-	-	-	-	-
		IV	0.16 B1 0.65 C 0.70 B1	0.15 0.60 0.68	-	-	-	0.65 R	-	-	-
		V	0.83 C 0.86 B1	0.82 0.86	-	-	-	-	-	-	-
		VI	0.94 B1	0.93	-	0.92 YG	-	-	0.92 B1	-	-
		VII	-	-	-	-	-	-	-	-	-
		VIII	0.93 B1	0.92	-	-	-	-	-	-	-
9.	<u>Tamarindus indica</u>	I	0.2 B1	0.2	-	-	-	-	-	-	-
		II	0.6 B1	0.6	-	-	-	-	-	-	-
		III	0.94 B1	0.90	-	-	-	-	-	-	-
		IV	0.68 B1	0.65	-	-	-	-	-	-	-
		V	0.80 B1	0.80	-	-	-	0.80 B1	-	0.78 G	-
		VI	0.90 B1 0.93 B1	0.90 0.92	-	-	-	-	-	0.90 G	0.90 B1
		VII	0.65 B1 0.70 B1	0.65 0.70	-	0.65 Y 0.68 Y	-	-	0.65 B1 0.68 B1	-	-
		VIII	0.35 B1	0.35	-	-	-	-	-	-	-
10.	<u>Cassia fistula</u>	I	0.1 B1	0.08	-	-	-	-	-	-	-
		II	0.75 B1	0.72	-	-	-	-	-	-	-
		III	0.8 B1 0.9 B1	0.78 0.90	-	-	-	-	-	-	-

Contd...

Table-9 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		IV	0.7 Bl	0.70	-	-	-	-	-	-	-
		V	0.60 PRo 0.70 PRo 0.80 Bl	0.60 0.70 0.80	-	-	0.60 Bl 0.70 Bl	-	-	-	0.60 Bl 0.70 Bl
		VI	0.40 Bl 0.90 Bl	0.40 0.85	-	-	-	-	-	0.42 V 0.82 V	0.42 Bl 0.82 Bl
		VII	0.95 Bl	0.93	-	0.92 Bl	-	-	0.92 O	-	-
		VIII	0.98 PRo	0.96	-	-	-	-	-	-	-
11.	<u>Mimosa pudica</u>	I	0.2 Bl	0.2	-	-	-	-	-	-	-
		II	0.6 Bl	0.58	-	-	-	-	-	-	-
		III	0.85 Bl 0.90 C	0.85 0.90	-	-	-	-	-	-	-
		IV	0.70 Bl	0.70	-	-	-	-	-	-	-
		V	0.80 Bl	0.75	-	-	0.80 Bl	-	-	-	-
		VI	0.20 Buff 0.90 Buff 0.93 Buff	0.18 0.85 0.92	-	-	0.85 Bl	0.20 Bl 0.90 Bl	-	-	-
		VII	-	-	-	-	-	-	-	-	-
		VIII	0.98 PRo	0.96	-	-	-	-	-	-	-
12.	<u>Alysiin scarabaeoides</u>	I	0.2 BG	0.2	-	-	0.2 Y	-	-	-	-
		II	0.6 Gr	0.6	-	0.6 Bl	0.6 Y	-	-	-	-
		III	0.9 Bl	0.9	-	0.9 Bl	0.9 Y	-	-	-	-
		IV	-	-	-	-	-	-	-	-	-
		V	-	-	-	-	-	-	-	-	-
		VI	-	-	-	-	-	-	-	-	-
		VII	0.65 Bl	0.65	-	-	-	-	-	-	-
		VIII	0.95 PRo 0.97 PRo	0.95 0.97	-	-	-	-	-	-	-
13.	<u>Thespesia populnea</u>	I	0.60 Bl	0.60	-	0.60 Bl	-	-	-	-	-

Contd....

Table-9 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		II	0.75 Bl	0.73	-	0.75 10 0.80 0	-	-	-	-	-
		III	0.30 Y 0.90 C	0.32 0.88	-	-	-	-	-	-	0.40 Gr 0.50 Gr 0.98 Gr
		IV	0.20 Gr 0.85 RoBl	0.82	-	-	-	0.82 R	-	-	-
		V	0.05 lBl 0.52 Bl	0.52 0.88	-	0.55 0 0.90 0	-	0.50 Bl	0.50 dO	0.54 G	-
		VI	0.08 Bl 0.90 Bl	0.1 0.88	0.08 Gr 0.80 V	0.80 0	0.1 Y 0.80 Y	0.85 Bl	-	-	0.85 Bl
		VII	0.1 R 0.5 R 0.8 R 0.98 R	0.1 0.50 0.78 0.75	0.5 Buff 0.8 Gr 0.97 R	0.95 0	0.80 Y 0.97 Y	-	0.97 0	-	0.80 Gr
		VIII	0.90 R 0.95 Bl	0.82 0.93	0.80 Gr 0.85 Buff 0.97 Gr.	0.97 0	0.80 Y 0.90 Y	-	0.98 0	-	0.99 Gr
14. <u>Abutilon indicum</u>		I	0.05 dO	-	-	-	-	-	-	-	-
		II	0.60 Bl 0.80 Bl	0.55 0.78	-	-	-	-	-	-	-
		III	0.85 C	0.85	-	-	-	-	-	-	-
		IV	0.6 C 0.75 C	0.56 0.73	-	-	-	-	-	-	-
		V	0.30 C 0.40 C 0.90 C	0.32 0.43 0.95	-	-	-	-	-	-	-
		VI	0.90 Bl	0.90	-	-	-	-	-	-	-
		VII	0.98 Bl	0.95	-	-	-	-	-	-	-
		VIII	0.98 Bl	0.98	-	-	-	-	-	-	-
15. <u>Hibiscus rosa-sinensis</u>		I	0-0.9 Bl run	0.90 0.30	-	-	-	-	-	-	-
		II	0.20 Bl	0.73 0.20	-	-	0.20 Bl	-	0.04 Y 0.90 Y	-	-

Contd...

Table-9 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		III	0.22 YB1	0.20 0.56 0.80	-	0.53 Y	-	-	-	-	-
		IV	-	-	-	-	-	-	-	-	-
		V	0.35 YB1	0.22 0.38 0.87	-	-	-	0.24 B1	-	-	-
		VI	-	0.32 0.58	-	-	-	-	-	-	-
		VII	0.32 YB1 0.34 YB1 0.80 YB1	0.30 0.55 0.80 0.98	-	0.82 Y 0.95 Y	-	0.60 B1	-	-	-
		VIII	0.90 Y	0.48 0.90	-	0.45 Y	-	-	-	-	-
16.	<u>Tinospora cordifolia</u>	I	0.58 B1	0.60	-	-	-	-	-	-	-
		II	0.80 YB1	0.10 0.80 0.92	-	-	-	-	-	-	-
		III	0.98 YB1	0.95	-	0.98 Y	-	-	-	-	-
		IV	0.85 Y	0.82	-	-	-	-	-	-	-
		V	-	-	-	-	-	-	-	-	-
		VI	-	-	-	-	-	-	-	-	-
		VII	-	-	-	-	-	-	-	-	-
		VIII	0.80 R	0.82	-	-	-	-	-	-	-
17.	<u>Eugenia jambolana</u>	I	0.70 B1 0.73 B1	0.72 0.72	-	-	-	-	-	-	-
		II	0.70 B1 0.80 B1	0.80	-	-	-	-	-	-	-
		III	-	-	-	-	-	-	-	-	-
		IV	-	-	-	-	-	-	-	-	-
		V	-	-	-	-	-	-	-	-	-

Contd...

Table-9 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		VI	0.92 B1	0.90	-	-	-	-	-	-	-
		VII	-	-	-	-	-	-	-	-	-
		VIII	-	-	-	-	-	-	-	-	-
18.	<u>Boerhaavia diffusa</u>	I	-	-	-	-	-	-	-	-	-
		II	-	0.40 0.75	-	-	-	-	-	-	-
		III	-	0.25 0.80	-	-	-	-	-	-	0.60 B1
		IV	-	-	-	-	-	-	-	-	-
		V	-	0.60	-	-	-	-	-	-	0.60 B1
		VI	-	0.35 0.60	-	-	-	-	-	-	0.50 B1
		VII	0.65 B1	0.25 0.65	-	0.25 B1 0-0.3 Bl.run	0.27 Y	-	-	-	0.65 B1
		VIII	0-0.7 Gr.run	0.30 0.80	-	-	-	-	-	-	0.80 B1
19.	<u>Nyctanthes arbor-tristis</u>	I	0.60 B1	0.58	-	-	-	-	-	-	-
		II	0.80 B1	0.79	-	0.80 B1	0.80 Y	0.80 R	-	-	-
		III	0.98 B1	0.98	-	-	-	0.98 R	0.98 O	-	-
		IV	0.22 Y	0.22 0.93	-	-	-	0.90 R	-	-	-
		V	-	0.92	-	-	-	0.96 R	0.96 O	0.96 G	-
		VI	0.9 B1	0.87	-	-	-	-	-	-	-
		VII	-	0.90	-	0.92 B1	-	-	0.92 O	-	-
		VIII	-	-	-	-	-	-	-	-	-
20.	<u>Averrhoa bilimbi</u>	I	0.20 B1	-	-	-	0-0.3 Buff run	-	-	-	-
		II	0.70 Br 0.80 Br	0.69 0.80	-	-	0.80 Buff	0.78 B1	0.82 B1	-	-

Contd...

Table-9 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		III	0.10 C 0.94 C 0.98 Br	0.08 0.92 0.98	-	0.96 B1	-	0.96 Buff	-	-	-
		IV	0.93 B1 0.95 B1	0.90 0.96	0.90 PRo 0.95 Buff	0.54 R 0.95 B1	-	0.96 Buff	-	-	-
		V	0.90 PRo	0.90	-	-	-	0.90 C	-	-	-
		VI	0.90 PRo	0.90	-	-	-	-	-	-	-
		VII	-	0.95	-	-	0.98 Y	-	-	-	-
		VIII	0.90 C	0.90	-	0.97 O	0.92 C	0.90 C	-	-	-
21. <u>Psychotria truncata</u>		I	-	-	-	-	-	-	-	-	-
		II	-	-	-	-	-	-	-	-	-
		III	0.85 C	0.85	-	-	-	-	-	-	-
		IV	0.6 C 0.75 C	0.55 0.72	-	-	-	-	-	-	-
		V	0.30 C 0.40 C 0.90 C	0.30 0.40 0.90	-	-	-	-	-	-	-
		VI	-	0.90	-	-	-	-	-	-	-
		VII	0.95 C	0.93	-	-	-	-	-	-	-
		VIII	0.98 C	0.96	-	-	-	-	-	-	-
22. <u>Oldenlandia corymbosa</u>		I	0.20 B1	0.20	-	0.33 P	-	-	-	-	-
		II	-	-	-	-	-	-	-	-	-
		III	0.60 R	0.58	-	0.60 P	0.68 YO	0.60 Y	0.60 Y	-	-
		IV	0.42 Gr	0.42	-	-	-	-	-	-	-
		V	0.24 B1 0.44 V	0.24 0.44 0.60	0.60 B1	0.45 PRo 0.60 PRo	0.47 V	-	0.40 Y	-	-
		VI	0.75 B1	0.56 0.66 0.75	0.72 V	0.56 V 0.66 PRo	0.63 YO	0.55 Y	0.55 Y 0.72 Y	-	0.70 B1
		VII	0.48 B1 0.85 B1	0.48 0.85	0.92 V	0.70 P	0.48 YO 0.85 YO	-	0.45 Y 0.85 B1	-	-

Contd...

Table-9 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		VIII	0.43 V 0.55 V	0.44 0.58	0.68 Gr	-	-	-	0.65 B1 0.75 B1	-	0.45 B1
23. <u>Muraya koenigi</u>		I	0.08 R	0.10 0.18 0.47	-	-	-	-	-	-	0.20 Gr 0.70 Gr.
		II	0.67 R	0.05 0.68	-	0.03 C 0.75 C	0.72 O	0.70 B1	-	0.30 G	0.30 Gr
		III	0.30 R 0.60 R	0.10 0.20 0.28 0.58	-	0.32 V	0.08 B1	0.05 P 0.28 VB1 0.33 B1 0.62 P	0.28 VB1 0.62 B1	-	-
		IV	0.40 V 0.75 Gr	0.45 0.80	-	0.48 Gr 0.80 dGr	0.48 YG 0.80 YO	-	-	-	-
		V	0.42 Y	0.10 0.18 0.42	-	0.45 Y	0.45 YO 0.4 Gr	0.38 P	-	-	-
		VI	0.9 Y	0.06 0.65 0.78	0.75 V	0-0.5 Y.run	-	-	-	-	0.75 Gr 0.88 Gr
		VII	0.95 R	0.15 0.80 0.96	-	0.8 B1	0.95 B1	0.68 G	0.80 B1Y	-	-
		VIII	0.40 R 0.60 O 0.65 O	0.28 0.40 0.60 0.65	-	-	-	-	-	-	0.30 Gr 0.60 Gr
24. <u>Mimrops kouki</u>		I	0.30 C	0.30 0.50	-	0.50 B1	-	-	0.50 Y	-	-
		II	0.45 C	0.12 0.42	-	-	-	-	-	-	-
		III	0.99 PRO	0.34 0.55 0.98	-	-	-	-	-	-	-
		IV	0.16 C 0.65 C	0.10 0.65	-	-	-	0.16 R 0.65 R	-	-	-
		V	0.83 C 0.93 RB1	0.35 0.83 0.93	-	-	-	-	-	-	-

Contd..

Table-9 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		VI	0.94 C	0.95	-	-	-	-	-	-	-
		VII	-	0.10	-	0.90 Bl	0.90 YO	-	-	-	-
		VIII	-	0.22 0.85	-	-	-	-	-	-	-
25. <u>Datura metel</u>		I	0.05 R 0.14 R 0.65 R	0.15 0.20 0.40 0.68 0.85	0.20 R 0.40 R	0.13 O 0.20 O	0.05 R 0.15 R	-	-	-	-
		II	0.55 Br 0.45 Gr 0.65 Gr	0.45 0.50 0.62	0.65 R	0.56 R	0.62 Bl	-	-	-	-
		III	0.04 R	0.04 0.42 0.85	-	0.84 O	0.04 O 0.82 O	-	-	0.82 R	0.42 Gr
		IV	0.23 O 0.75 O	0.22 0.74	-	0.75 Buff	0.72 O	-	-	-	-
		V	0.10 O 0.30 O 0.55 O 0.80 O	0.13 0.32 0.55 0.78	-	0.32 Bl	0.10 O 0.30 O	-	0.35 YO	-	0.55 Bl
		VI	0.67 Bl 0.86 Bl	0.14 0.28 0.58 0.85	0.70 R	0.56 Bl 0.85 Bl	0.55 O 0.85 O	-	0.83 YO	-	0.82 Bl
		VII	-	0.82 0.90	-	0.82 Bl 0.90 Bl	-	-	0.92 YO	-	-
		VIII	0.28 O 0.34 O 0.44 O 0.55 O 0.75 O	0.26 0.35 0.45 0.55 0.73	-	0.29 Bl	0.28 O 0.56 O 0.72 O	-	0.56 YO 0.70 YO 0.79 YO	-	-
26. <u>Grewia microcos</u>		I	0.90 C	0.90	-	0.90 Bl	-	-	-	-	-
		II	0.65 C 0.70 C	0.65 0.72	-	0.65 Bl 0.70 Bl	-	-	-	-	-

Contd...

Table-9 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		III	0.70 C 0.73 C	0.45 0.68 0.75	-	-	-	-	-	-	-
		IV	0.70 C	0.15 0.68 0.85	-	-	-	-	-	-	-
		V	0.90 O	0.34 0.90	-	-	-	-	-	-	-
		VI	0.90 O 0.92 C	0.90 0.92	-	-	-	-	-	-	-
		VII	0.90 O	0.90	-	-	-	-	-	-	-
		VIII	0.90 O	0.65 0.80	-	-	-	-	-	-	-
27. <u>Lantana camara</u>		I	0.04 R 0.10 R 0.22 R	0.08 0.12 0.20 0.35	-	0.10 O	0.10 O	-	-	-	-
		II	0.45 Gr 0.57 Bl	0.28 0.34 0.42 0.58	-	0.48 O 0.60 O	-	-	-	-	-
		III	0.05 Bl 0.72 Bl	0.10 0.72	-	-	-	0.71 Bl	-	-	-
		IV	0.09 PRo 0.17 O 0.65 Bl 0.72 Gr	0.1 0.15 0.45 0.65 0.75	-	0.75 O	0.18 Bl 0.68 Bl	0.16 Bl	-	-	-
		V	0.41 O 0.52 O 0.59 O 0.80 dO	0.22 0.38 0.42 0.58 0.78	-	-	0.50 O 0.60 O 0.78 O	-	-	-	-

Contd...

Table-9 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		VI	0.26 B1 0.56 B1 0.67 B1 0.86 R	0.20 0.26 0.55 0.65 0.85	0.56 V 0.85 V	0.55 O 0.66 O	-	-	-	-	-
		VII	-	0.82 0.92	-	0.82 O 0.92 O	0.85 O	0.83 B1	0.83 Y	0.83 G	0.83 B1
		VIII	0.15 B1 0.41 B1 0.55 B1 0.74 B1	0.15 0.24 0.40 0.54 0.75	-	0.22 B1Gr	0.45 O 0.70 O	0.45 B1 0.70 B1	-	-	-
28.	<u>Cymbopogon citratus</u>	I	0.24 B1	0.08 0.24	-	0.08 B1	-	-	0.24 Y	-	-
		II	0.95 B1	0.40 0.88 0.93	-	0.89 B1	-	-	-	-	0.36 B1
		III	0.97 B1	0.92 0.97	-	-	0.97 O	0.95 B1	-	-	0.95 B1
		IV	0.65 B1	0.62 0.65	-	-	-	-	-	-	-
		V	0.86 B1	0.54 0.85	-	-	-	-	-	-	-
		VI	0.93 B1	0.82 0.95	-	-	-	-	-	-	-
		VII	-	-	-	-	-	-	-	-	-
		VIII	0.85 O	-	-	-	-	-	-	-	-

T A B L E - 10  
THIN LAYER CHROMATOGRAPHIC STUDY OF BARK EXTRACTS

S.No.	Name of the Drug	Solvent system	UV Rf.Colour	I <sub>2</sub> Rf	Anisaldehyde Rf.Colour	AlCl <sub>3</sub> Rf.Colour	AmIICl <sub>3</sub> Rf.Colour	KOH Rf.Colour	Lead acetate Rf.Colour	FeCl <sub>3</sub> Rf.Colour	Folin ciocalteu Rf.Colour
1	2	3	4	5	6	7	8	9	10	11	12
1.	<u>Spondius pinnata</u>	I	-	0.60	-	-	-	-	-	-	-
		II	-	0.75	-	-	-	-	-	-	-
		III	-	0.90	-	-	-	-	-	-	-
		IV	-	0.85	-	-	-	0.83 Y	-	-	-
		V	-	0.90	-	-	-	-	-	0.88 Bl	-
		VI	0.05 Bl 0.80 Bl	0.08 0.10 0.78	0.05 R 0.10 Bl 0.79 Bl	0.80 Bl	0.80 Y	-	-	0.82 Bl	0.80 Bl
		VII	0.98 Bl	0.99	-	0.98 Bl	-	-	0.98 Y	-	-
		VIII	0.90 Bl	0.90	-	0.87 Bl	0.90 Y0	-	0.90 R	-	-
2.	<u>Annona squamosa</u>	I	-	-	-	-	-	-	-	-	-
		II	-	-	-	-	-	-	-	-	-
		III	-	-	-	-	-	-	-	-	-
		IV	-	0.54	-	-	-	0.54 R	-	-	-
		V	-	0.68	0.68 R	-	-	-	-	-	0.70 Bl
		VI	0.70 Bl	0.70	0.68 R	-	-	-	-	0.68 G	0.70 Bl
		VII	-	-	-	-	-	-	-	-	-
		VIII	-	-	-	-	-	-	-	-	-
3.	<u>Polyalthia fragrans</u>	I	-	-	-	-	-	-	-	-	-
		II	0.35 Gr 0.80 RoBl	0.06 0.35	-	0.50 Y	0.36 Gr 0.50 Gr 0.80 Gr	-	0.04 OR 0.50 Y	-	-
		III	-	0.46 0.80	-	-	-	-	-	-	-
		III	0.10 RoBl 0.30 Bl	0.12 0.28 0.42	-	0.10 BlV 0.26 BlV	-	-	-	-	-
		IV	-	-	-	-	-	-	-	-	-

Contd...

Table-10 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		V	-	0.30 0.60	0.28 Gr 0.58 Gr	-	-	0.58 V	-	0.35 G 0.58 G	0.60 LB1 0.30 LB1
		VI	-	0.10 0.26	-	-	-	-	-	0.08 RoB1 0.24 B1	0.10 LB1 0.50 LB1
		VII	-	0.98	-	-	-	0.96 Y	-	-	-
		VIII	0.30 LB1 0.80 LB1 0.94 LB1	0.30 0.78 0.90	0.75 Lav.	0.98 Y	-	0.30 V 0.93 VB1	-	-	-
4.	<u>Holarrhena antidysenterica</u>	I	0.15 G	0.15 0.82	-	0.79 Y	-	-	-	-	-
		II	0.70 G	0.70	-	-	-	-	-	-	-
		III	-	0.72	-	-	-	-	-	-	-
		IV	0.80 G	0.78	0.75 Gr	-	-	0.75 B1	-	-	-
		V	0.90 G	0.90	-	-	-	-	-	-	-
		VI	0.85 G	0.79	0.90 V	-	-	-	-	0.89 B1	-
		VII	-	0.76	-	0.80 B1	0.76 YB1	-	-	-	-
		VIII	-	0.05 0.78	-	0.80 B1	0.80 B1	-	-	-	-
5.	<u>Oroxylum indicum</u>	I	0.55 B1	0.55	-	-	-	-	-	-	-
		II	0.70 B1	0.75	-	-	-	-	-	-	-
		III	0.20 B1 0.30 B1	0.20	-	-	-	-	-	-	-
		IV	0.87 B1	0.87	-	-	-	-	-	-	-
		V	0.08 B1 0.90 B1	0.10 0.90	0.90 Gr	-	-	-	-	0.90 R	-
		VI	0.40 B1 0.45 B1	0.40 0.42	-	-	-	-	-	-	-

Contd...

Table-10 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		VII	0.90 B1	0.90	0.88 Gr	-	-	-	-	0.90 R	0.90 B1
		VIII	-	-	-	-	-	-	-	-	-
6.	<u>Croton oblongifolius</u>	I	-	-	-	-	-	-	-	-	-
		II	-	0.42 0.88	-	0.45 B1	0.90 B1	-	-	-	-
		III	-	0.08 0.20	-	0.05 B1	-	0.22 B1	-	-	-
		IV	0-0.40 YG run	0-0.40 run	-	-	-	-	-	-	-
		V	0-0.90 YG run	0-0.90 run	-	0.97 YG	-	-	-	-	-
		VI	0.90 YG	0.90	-	-	-	-	-	0.90 V	-
		VII	0.98 YG	0.98	-	0.98 Aquam.	-	-	-	-	-
		VIII	0.90 1B1	0.90 0.96	-	0.98 1B1	-	0-0.90 B1 run	-	-	-
7.	<u>Ricinus communis</u>	I	-	-	-	-	-	-	-	-	-
		II	-	-	-	-	-	-	-	-	-
		III	0.60 B1	0.20 0.62	-	0.60 Y	-	-	-	0.60 Y	0.60 B1
		IV	0.82 B1	0.85	-	-	-	-	-	0.85 B1	-
		V	-	-	-	-	-	-	-	-	-
		VI	0.94 B1	0.64 0.92	-	0.92 B1	-	-	-	-	-
		VII	0.70 B1	0.64 0.70	-	0.73 B1	-	-	0.72 B1	-	-
		VIII	0.95 B1	0.18 0.95	-	0.92 B1	-	-	-	-	-

Contd...

Table-10 continued...

1	2	3	4	5	6	7	8	9	10	11	12
8.	<u>Hydrocarpus wightiana</u>	I	-	0.83	-	-	0.85 YO	-	-	-	-
		II	-	0.08 0.72	-	-	-	0.73 B1	-	-	-
		III	-	0.62	-	-	-	-	-	-	-
		IV	-	0.90	-	-	0.90 YO	-	-	-	-
		V	0.92 B1	0.95	0.93 V	-	-	-	-	0.93 V	0.90 Gr
		VI	0.95 B1	0.95	-	-	-	-	-	-	-
		VII	0.85 B1	0.82	-	0.85 Y	-	-	0.85 B1	-	-
		VIII	-	0.85	-	-	0.90 YO	-	-	-	-
9.	<u>Machilus macrantha</u>	I	-	0.15	-	-	-	-	-	-	-
		II	-	0.70	-	-	-	-	-	-	-
		III	-	0.20	-	0.20 B1	-	-	-	-	-
		IV	-	0.80	-	-	-	-	-	-	-
		V	0.73 B1	0.80	0.80 B1	-	0.76 O	-	-	-	0.78 Gr
		VI	-	-	-	-	-	-	-	-	-
		VII	-	-	-	-	-	-	-	-	-
		VIII	-	0.90	-	0.92 Y	-	-	-	-	-
10.	<u>Pterocarpus marsupium</u>	I	-	-	-	-	-	-	-	-	-
		II	-	-	-	-	-	-	-	-	-
		III	0.66 B1	0.70	-	-	-	-	-	-	-
		IV	-	-	-	-	-	-	-	-	-
		V	0.30 G 0.33 RoB1 0.40 Mt 0.52 RoB1	0.30 0.40 0.55	0.40 V 0.50 VB1	-	-	-	0.28 EG	0.30 B1	0.30 Gr

Contd...

Table-10 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		VI	0.80 B1	0.78	0.78 VB1	-	-	-	-	-	0.80 Gr
		VII	0.93 B1	0.90	-	0.90 Y	-	-	0.88 G	-	0.90 Gr
		VIII	-	-	-	-	-	-	-	-	-
11.	<u>Tamarindus indica</u>	I	-	0.50	-	0.50 B1	0.50 B1	-	-	-	-
		II	-	0.70	-	-	-	-	-	-	-
		III	-	0.30 0.50	-	-	-	0.30 B1	-	-	-
		IV	-	-	-	-	-	-	-	-	-
		V	0.42 B1 0.88 B1	0.44 0.90	0.90 B1	-	-	0.40 YB1	0.85 YD	0.90 G	0.86 B1
		VI	-	0.60	-	-	-	0.60 YB1	-	-	0.60 B1
		VII	-	0.60	-	0.63 YG	-	-	0.63 O	-	-
		VIII	0.90 B1	0.87	-	0.90 YG	-	0.90 YBL	-	-	-
12.	<u>Cassia fistula</u>	I	-	0.60	-	-	-	-	-	-	-
		II	-	0.75	-	-	-	-	-	-	-
		III	-	-	-	-	-	-	-	-	-
		IV	-	0.42	-	-	-	0.45 YB1	-	-	0.40 B1
		V	0.87 B1	0.90	-	-	-	-	-	0.87 G	-
		VI	-	-	-	-	-	-	-	-	-
		VII	0.90 B1	0.84	-	0.90 O	-	-	0.90 R	-	0.85 B1
		VIII	-	-	-	-	-	-	-	-	-
13.	<u>Moringa pterygosperma</u>	I	-	-	-	-	-	-	-	-	-
		II	-	-	-	-	-	-	-	-	-
		III	0.70 B1	0.70	-	-	-	-	-	-	-
		IV	0.73 B1	0.72	-	-	-	-	-	-	-
		V	0.50 B1	0.50	0.45 B1	-	-	-	0.50 B1	-	0.46 B1
		VI	-	-	-	-	-	-	-	-	-

Contd...

Table-10 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		VI	-	-	-	-	-	-	-	-	-
		VII	0.92 B1	0.98	-	0.95 B1	-	-	0.98 YR	-	-
		VIII	-	-	-	-	-	-	-	-	-
14.	<u>Eucalyptus globulus</u>	I	-	-	-	-	-	-	-	-	-
		II	-	-	-	-	-	-	-	-	-
		III	-	-	-	-	-	-	-	-	-
		IV	-	-	-	-	-	-	-	-	-
		V	0.75 B1	0.72	0.75 B1	-	-	-	0.69 YO	-	-
		VI	-	-	-	-	-	-	-	-	-
		VII	0.75 B1	0.74	-	0.75 YG	-	-	0.73 Y	-	-
		VIII	-	-	-	-	-	-	-	-	-
15.	<u>Careya arborea</u>	I	0.20 1B1	0.20	-	0.90 B1	-	-	-	-	-
		II	0.80 1B1	0.50 0.80	-	0.50 B1	-	-	0.50 YO	-	-
		III	-	0.94	-	-	-	-	-	-	-
		IV	0.92 1B1	0.95	-	-	-	-	-	-	-
		V	0.90 1B1	0.85	-	0.90 YB1	-	-	0.90 YO	-	0.85 B1
		VI	0.92 1B1	0.30 0.65 0.90	-	0.32 YB1 0.60 1B1	-	-	-	-	-
		VII	-	0.85	-	0.85 YB1	-	0.85 B1	0.88 YO	0.85 R	-
		VIII	0.98 1B1	0.95	-	0.95 B1	-	-	-	-	-
16.	<u>Nyctanthes arbor-tristis</u>	I	0.58 B1	0.60	-	-	-	-	-	-	-
		II	0.76 B1	0.76	-	-	-	-	-	-	-
		III	-	-	-	-	-	-	-	-	-

Contd...

Table-10 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		IV	-	-	-	-	-	-	-	-	-
		V	0.90 B1	0.90	0.88 B1	-	-	-	-	0.85 V	-
		VI	0.05 B1 0.80 B1	0.08 0.82	0.85 B1	-	-	-	-	0.85 V	-
		VII	-	-	-	-	-	-	-	-	-
		VIII	-	0.95	0.97 B1	-	-	-	-	-	-
17.	<u>Zizyphus rugosa</u>	I	0.18 B1	0.15	-	-	-	-	-	-	-
		II	0.60 B1	0.44 0.58	-	-	-	0.40 YB1 0.60 YB1	-	-	-
		III	-	0.42	-	-	-	-	-	-	-
		IV	-	0.73	-	-	0.73 B1	-	-	-	-
		V	-	0.20 0.65	0.65 B1	-	-	-	-	-	-
		VI	-	0.65	-	-	-	-	-	-	-
		VII	-	0.82	-	0.85 B1	-	-	0.83 B1	-	-
		VIII	-	-	-	-	-	-	-	-	-
18.	<u>Zizyphus jujuba</u>	I	-	-	-	-	-	-	-	-	-
		II	-	-	-	-	-	-	-	-	-
		III	-	-	-	-	-	-	-	-	-
		IV	0.65 B1	0.62	-	-	-	-	0.65 R	-	-
		V	0.81 B1	0.10 0.80	-	-	0.14 B1	0.80 YB1	0.10 B1	0.80 V	-
		VI	0.94 B1	0.94	-	-	-	-	-	-	-
		VII	0.75 B1 0.83 B1	0.72 0.82	-	0.73 YB1 0.85 YB1	-	-	0.70 YO 0.85 B1	-	-
		VIII	-	0.78	-	0.80 YB1	-	-	-	-	-

Contd...

Table-10 continued...

1	2	3	4	5	6	7	8	9	10	11	12	
19.	<u>Psychotria truncata</u>	I	0.60 B1	0.60	-	-	-	-	-	-	-	-
		II	0.75 B1	0.72	-	-	-	-	-	-	-	-
		III	-	-	-	-	-	-	-	-	-	-
		IV	-	-	-	-	-	-	-	-	-	-
		V	-	-	-	-	-	-	-	-	-	-
		VI	0.10 B1 0.80 B1	0.10 0.82	0.08 V 0.80 V	-	-	-	-	-	0.80 R	-
		VII	0.45 B1	0.42	0.40 B1	0.40 BG	-	-	-	0.45 R	-	-
		VIII	0.92 B1	0.95	0.97 B1	-	-	-	-	-	-	-
20.	<u>Zanthoxylum rhetsa</u>	I	0.18 B1	0.16	-	0.20 B1	-	0.20 B1	-	-	-	-
		II	0.60 B1	0.56	-	-	-	0.58 B1	-	-	-	-
		III	0.50 PRo 0.57 PRo 0.74 PRo	0.50 0.55 0.72	-	-	0.50 YO 0.57 Y 0.70 OBI	0.74 B1	-	-	-	-
		IV	0.22 B1 0.73 B1	0.20 0.70	-	-	0.22 B1 0.73 YO	-	-	-	-	-
		V	0.30 RB1	0.30	0.30 V	-	-	-	-	-	-	-
		VI	0.45 B1 0.80 B1	0.45 0.82	0.45 V	0.45 YO 0.80 YO	-	-	0.50 QR 0.80 QR	0.50 R	-	-
		VII	0.90 E.G.	0.88	-	0.90 YO	-	-	0.90 YO	-	-	-
		VIII	0.90 E.G.	0.88	-	0.90 B1	-	0.90 YO	-	-	-	-
21.	<u>Allophylus cobbe</u>	I	0.35 B1	0.30	-	-	-	-	0.35 B1	-	-	
		II	-	0.22 0.62	-	0.22 B1 0.60 B1	0.20 B1	-	0.19 dB1 0.59 Gr	-	-	
		III	0.60 R	0.60	-	-	-	-	-	-	-	
		IV	0.50 B1	0.45	-	-	-	-	-	-	-	
		V	0.40 B1 0.61 B1	0.20 0.40 0.60 0.75	0.40 V	0.45 R 0.75 R	0.18 YO 0.45 YO	-	-	-	-	

Contd...

Table-10 continued...

1	2	3	4	5	6	7	8	9	10	11	12
		VI	0.75 B1	0.40 0.60 0.72	0.75 V	0.76 YO	0.42 YO	0.40 B1 0.58 B1	-	-	-
		VII	0.84 B1	0.80	-	-	0.84 B1	-	-	-	-
		VIII	0.40 B1 0.55 V	0.40 0.50	-	-	-	-	-	-	-
22.	<u>Mimusops elengi</u>	I	-	-	-	-	-	-	-	-	-
		II	-	-	-	-	-	-	-	-	-
		III	-	-	-	-	-	-	-	-	-
		IV	0.34 B1	0.32	-	-	-	0.35 B1	-	-	-
		V	0.30 B1	0.30	-	0.30 YO	-	-	-	0.30 R	-
		VI	0.80 B1	0.82	0.82 V	-	-	-	-	0.80 R	0.80 B1
		VII	0.90 B1	0.90	-	-	-	-	-	-	-
		VIII	0.90 B1	0.92	-	-	-	-	-	-	-
23.	<u>Helicteres igora</u>	I	-	0.13 0.75	0.74 B1	0.15 B1 0.75 B1	-	-	-	-	-
		II	-	0.18 0.28	-	0.25 V	-	0.25 B1	0.25 B1	-	-
		III	-	-	-	-	0.70 B1	-	-	-	-
		IV	-	-	-	-	-	-	-	-	-
		V	0.37 V	0.35 0.45 0.60	-	0.45 RV	0.45 V	0-0.6 B1 run	0.45 B1	-	-
		VI	0.62 GY	0.52 0.60	-	0.55 B1	0.63 B1	0.52	0.52 B1	-	-
		VII	0.36 V 0.50 B1	0.36 0.50	-	-	0.36 Y 0.50 B1	-	-	-	-
		VIII	0.42 UB1 0.47 V 0.54 V	0.46 0.52	-	0.38 B1 0.42 B1	0.42 B1 0.54 B1	-	0.50 B1 0.62 B1 0.72 B1	-	-

Contd...

Table-10 continued...

1	2	3	4	5	6	7	8	9	10	11	12
24.	<u>Sterculia urens</u>	I	-	-	-	-	-	-	-	-	-
		II	-	-	-	-	-	-	-	-	-
		III	0.90 Bl	0.90	-	-	-	-	-	-	-
		IV	0.25 Bl	0.26	-	-	-	0.25 Bl	-	-	-
		V	-	0.45	0.48 Bl	-	0.46 dB1	-	-	0.45 V	0.45 Bl
		VI	-	-	-	-	-	-	-	-	-
		VII	0.70 Buff	0.72	-	0.72 Bl	0.70 Bl	-	0.72 Y	-	-
		VIII	0.95 Bl	0.90	-	-	-	-	-	-	-
25.	<u>Grewia microcos</u>	I	-	-	-	-	-	-	-	-	-
		II	-	-	-	-	-	-	-	-	-
		III	-	-	-	-	-	-	-	-	-
		IV	-	-	-	-	-	-	-	-	-
		V	0.15 Bl	0.15	0.15 Bl	-	-	0.15 Bl	-	-	-
		VI	-	-	-	-	-	-	-	-	-
		VII	-	0.15	-	0.15 Bl	-	-	0.15 Y	0.15 V	0.15 Bl
		VIII	-	-	-	-	-	-	-	-	-
26.	<u>Ficus bengalensis</u>	I	-	-	-	-	-	-	-	-	-
		II	0.60 Bl	0.58	-	-	-	-	-	-	-
		III	-	-	-	-	-	-	-	-	-
		IV	0.73 Bl	0.05 0.72	-	-	0.73 YO	0.73 Y	0.05 Bl 0.72 Bl	-	0.70 Gr 0.80 Gr
		V	-	0.70	0.70 Bl	0.72 Bl	-	-	-	0.72 G	-
		VI	-	0.72	-	-	-	-	-	0.72 G	-
		VII	-	0.65	-	0.65 Bl	-	-	0.65 Bl	-	-
		VIII	-	-	-	-	-	-	-	-	-
27.	<u>Vitex negundo</u>	I	-	0.90	-	0.94 Bl	-	-	-	-	-

Cont. . . .

Table-10 continued...

1	2	3	4	5	6	7	8	9	10	11	12		
		II	0.03 IG 0.57 IG	0.02 0.10	0.11 Gr 0.45 Gr	0.56 Bl	-	-	0.04 Bl	-	-		
		III	0.12 IG	0.10	-	-	-	0.10 Bl	-	-	-		
		IV	0.11 RoBl	<del>0.10</del> 0.55 0.85	0.50 Y 0.85 Y	-	0.11 YO	0.11 Bl	0.11 Bl	-	0.10 Bl		
		V	0.45 Bl 0.77 Bl	0.32 0.39 0.50	0.63 V 0.65 V	0.32 Bl 0.39 Bl	0.32 Y 0.38 Y	0.36 Bl	-	-	-		
		VI	0.37 Bl 0.42 Bl	0.37 0.40	-	0.40 Bl	-	-	-	-	-		
		VII	0.74 Bl 0.91 Bl	-	-	-	-	-	-	-	-		
		VIII	0.42 Bl 0.60 Bl 0.71 Bl	0.08 0.25 0.40 0.60 0.69	0.42 Bl 0.60 Bl 0.69 Bl	0.25 YG	0.42 YG 0.56 YG 0.70 O	-	0.07 Buff 0.25 Buff 0.40 Gr 0.61 Gr	-	-		
28.	<u>Corallina arborea</u>	I	0.5 Y	0.10 0.15	-	-	-	-	-	-	-		
		II	0.70 YG	0.68	-	-	-	-	-	-	-		
		III	0.20 YG	0.20	-	-	-	-	-	-	-		
		IV	-	-	-	-	-	-	-	-	-		
		V	0.10 Y	0.12	0.10 V	0.15 Y	-	0.13 Bl	-	0.13 G	-		
		VI	0.40 Y	0.40	-	-	-	-	-	-	-		
		VII	0.65 Y	0.63 0.78	0.65 V	0.68 YO	0.68 YO 0.80 YG	-	0.68 Bl	-	0.65 Gr 0.78 Gr		
		VIII	-	0.82	0.82 V	0.82 YO	0.85 YO	-	-	-	-		
		Aq	- aquamarine		d	- dark		l	- light		F	- Pink	
		Bl	- Blue		EG	- emerald green		Lav	- lavender		FRo	- pink rose	
		Br	- brown		G	- green		Mag	- magenta		R	- red	
		C	- cinnamon		Gr	- grey		O	- orange		RoBl	- Royal blue	
											UBl	- Ultra blue	
											V	- violet	
											Y	- Yellow	

TLC PATTERN AND TWO DIMENSIONAL PAPER CHROMATOGRAPHIC  
STUDY OF METHANOLIC EXTRACT OF THE DRUGS FOR FLAVONOIDS

The chemistry of natural products has been highly advanced in recent years because of the development of modern techniques for isolation and purification of plant constituents and rapid and accurate analytical methods available for their identification. Phytochemical investigations on various plants have not only yielded many compounds of medicinal importance but have also enriched our knowledge of the subject and of chemotaxonomy.

Flavonoids, which probably stimulated the interest of early phytochemists because of their bright colours, have gained more importance in recent years due to a number of diversified reasons. These water soluble pigments provide a major contribution to the colours of flowers and fruits and represent one of the largest groups of plant phenolics. Flavonoids being secondary plant constituents play a significant role as chemotaxonomic and phylogenetic markers by virtue of their wide spread and uniform distribution in higher plants and structural variability as reported by Bate-Smith (1962) and Harbourne (1967).

Flavonoids include a group of naturally occurring compounds in which two benzene rings are joined together by a propane bridge i.e.  $C_6-C-C-C-C_6$ . The flavonoids, therefore include the following classes of compounds in the increasing state of oxidation:-

Catechins, dihydroxychalcones, chalcone, flavanols, flavanones, isoflavanones, flavones, isoflavones, biflavones, anthocyanins, aurones and flavonols.

Flavonoids have been found to occur at least in traces in almost all plants from pteridophyta to angiosperms. Ferns almost resemble angiosperms both

in the type of flavonoids present and their distribution pattern. With the exception of chalcones, all types of flavonoids found in ferns, occur in gymnosperms with a more or less similar distribution pattern. The most characteristic and distinguishing chemical constituents of gymnosperms (except the families pinaceae & ephedraceae) are biflavonyls which are rare outside this class. In contrast to their restricted occurrence in lower plants, all types of flavonoids are widely distributed in angiosperms. The flavonoid distribution pattern in monocot is almost similar to that in dicot, except that aurones and a few highly hydroxylated flavones like quercetagenin and scutellarein are relatively infrequent in monocots.

Considering the fact that the flavonoids are widely distributed in plants it was thought to utilise this class of compounds as finger prints or markers for the identification of plant samples. The crude methanolic extracts were run in a developing solvent, ethyl acetate : formic acid : water (8 : 1 : 1 ) on TLC plates and Rf values and spot colours were observed in UV as well as after spraying with boric acid reagent, which is prepared by mixing 3% aqueous boric acid solution and 10% aqueous oxalic acid solution in the proportion of 3 : 1. The said extracts were also subjected to two dimensional paper chromatography in developing solvents, TBA & acetic acid as suggested by Mabry et al (1970). The results of these two techniques of chromatography are given in Tables 11, 12, 13 and 14 for methanolic extracts of root, seed, leaf & bark respectively.

TLC PATTERN AND TWO DIMENSIONAL  
PAPER CHROMATOGRAPHIC STUDY OF  
METHANOLIC EXTRACT OF THE  
DRUGS FOR FLAVONOIDS.

T A B L E - 11

TLC study of methanolic extracts of roots using ethyl acetate : formic acid and water (80 : 10 : 10) as developing solvent and boric acid-oxalic acid as spray reagent.

Two dimensional paper chromatographic study of methanolic extracts of roots using tertiary butanol : glacial acetic acid water (3 : 1 : 1) for first run and 15% glacial acetic acid for second run and detection of spots by exposure to ammonia vapours.

S.No.	Name of the Drug	UV without spray		UV with spray		UV without spray		UV with ammonia exposure	
		Colour	Rf	Colour	Rf	Colour	Location	Colour	Location
1	2	3	4	5	6	7	8	9	10
1.	<u>Adhatoda vasica</u>	-	-	Light Blue Light Violet	0.56 0.78	1)Blue tint 2)Light violet	HI 3 - 6 HI 6 - 7	Blue tint Dark violet	HI 3 - 6 HI 6 - 7
2.	<u>Hemidesmus indicus</u>	Midsummer Bluish green Light violet Light green	0.22 0.35 0.55 0.65	Blue	0.20	1)Yellowish blue 2)Light blue 3)Light Blue 4)Light green 5)Violet -	GI 0 - 1 FG 1 - 2 GH 4 - 6 GI 7 - 8 DG 7 - 9 -	Dark Yellow Light Blue Light blue Light green Dark violet 6)Light green	GI 0 - 1 FG 1 - 2 GH 4 - 6 GI 7 - 8 DG 7 - 9 GI 6 - 7
3.	<u>Rauwolfia serpentina</u>	Dark violet Violet Violet Light green Violet	0.73 0.80 0.90 0.95 0.98	Blue fluor.	1.00	1)Yellowish brown 2)Yellow 3)Light blue 4)Blue 5)Violet brown 6)Light Yellow 7)Light orange	GH 1 - 2 GH 1 - 2 GH 2 - 4 GH 3 - 6 GH 4 - 6 FG 4 - 5 BF 1 - 2	Yellowish brown Dark yellow Light blue Blue Dark violet Light yellow Light orange	GH 1 - 2 GH 1 - 2 GH 2 - 4 GH 3 - 6 GH 4 - 6 FG 4 - 5 BF 1 - 2
4.	<u>Capparis zeylanica</u>	-	-	-	-	1)Light orange 2)Light orange 3)Light orange	HI 1 - 2 GH 3 - 5 HI 5 - 6	Light orange Light orange Light orange	HI 1 - 2 GH 3 - 5 HI 5 - 6

Table-11 continued...

1	2	3	4	5	6	7	8	9	10
						4)Light orange	CE 1 - 3	Light orange	CE 1 - 3
								5)Light blue	GH 2 - 3
5. <u>Viburnum foetidum</u>	-	-	Light green	0.25	1)Blue	BD 1 - 2	Blue	ED 1 - 3	
			Light green	0.45	2)Yellow	GH 1 - 2	Dark yellow	GH 1 - 2	
					3)Yellow	GH 1 - 2	Yellow	GH 1 - 2	
					4)Yellow	GH 2 - 3	Yellow G	GH 2 - 3	
					5)Blue	GH 2 - 6	Blue	GH 2 - 6	
					6)Yellowish brown	DG 4 - 6	Dark yellowish brown	DG 4 - 6	
6. <u>Momordica dioica</u>	-	-	-	-	1)Light yellow	FH 1 - 2	Light yellow	FH 1 - 2	
					2)Dark blue	EG 1 - 3	Dark blue	EG 1 - 3	
					3)Light blue	EH 5 - 8	Light blue	EH 5 - 8	
					4)Light green	EG 3 - 5	Dark green	EG 3 - 5	
7. <u>Croton oblongifolius</u>	-	-	-	-	1)Yellow tint	HI 1 - 2	Yellow tint	HI 1 - 2	
					2)Yellow tint	HI 1 - 2	Yellow tint	HI 1 - 2	
					3)Light orange	GH 2 - 5	Light orange	GH 2 - 5	
8. <u>Cassia esculenta</u>	Light yellow	0.75	Dark green fluor.	0.95	1)Brownish grey	AC 1 - 2	Dark brown	AC 1 - 2	
					2)Yellow	CG 2 - 4	Yellow	CG 2 - 4	
					3)Yellow	AC 2 - 5	Yellow	AC 2 - 5	
					4)Bright yellow	DG 4 - 6	Bright yellow	DG 4 - 6	
					5)Light yellow	CE 6 - 8	Light yellow	CE 6 - 8	
					6)Dark violet	EG 8 - 9	Dark yellow	EG 8 - 9	

Contd...

Table-11 continued...

1	2	3	4	5	6	7	8	9	10
9. <u>Arundinella gigantea</u>	Light blue	0.80	Light violet	0.35	1)Light yellowish green	HI 1 - 2	Light yellowish green	HI 1 - 2	
	Light violet	0.95			2)Light yellowish green	GH 1 - 2	Light yellowish green	GH 1 - 2	
					3)Blue	GH 3 - 5	Blue	GH 3 - 5	
					4)Blue	GH 4 - 5	Blue	GH 4 - 5	
					5)Light yellow	GI 4 - 5	Light yellow	GI 4 - 5	
					-	-	6)Light blue	GH 5 - 7	
10. <u>Leucas aspera</u>	Light blue	0.75	-	-	1)Light yellow	GH 1 - 2	Light yellow	GH 1 - 2	
					2)Light yellow	GH 1 - 2	Light yellow	GH 1 - 2	
					3)Light yellow	GH 1 - 2	Light yellow	GH 1 - 2	
					4)Blue	FH 4 - 6	Blue	FH 4 - 6	
					5)Yellowish green	GH 5 - 7	Yellowish green	GH 5 - 7	
11. <u>Pterocarpus marsupium</u>	Blackish grey	0.95	-	-	1)Brown	BH 0 - 2	Brown	BH 0 - 2	
					2)Light yellow	EF 2 - 3	Light yellow	EF 2 - 3	
					3)Blue	EF 2 - 4	Blue	EF 2 - 4	
					4)Light yellow	EF 4 - 6	Light yellow	EF 4 - 6	
					5)Light blue	GH 5 - 7	Light blue	GH 5 - 7	
					6)Dark violet	CE 4 - 6	Dark violet	CE 4 - 6	
					-	-	7)Light green	EF 5 - 7	
12. <u>Caesalpinia crista</u>	-	-	-	-	1)Light green	FG 1 - 2	Light green	FG 1 - 2	
					2)Light green	GH 1 - 2	Light green	GH 1 - 2	
					3)Light green	GH 5 - 6	Light green	GH 5 - 6	
					4)Greenish blue	EH 6 - 8	Dark green	EH 6 - 8	
					-	-	5)Light green	DG 3 - 4	

Contd....

Table-11 continued....

1	2	3	4	5	6	7	8	9	10
13. <u>Asparagus racemosus</u>	Light green	1.00	-	-	-	1)Yellow 2)Yellowish fluor.	HI 1 - 2 HI 6 - 7	Yellow Yellowish fluor.	HI 1 - 2 HI 6 - 7
14. <u>Smilax macrophylla</u>	-	-	-	-	-	1)Light blue	HI 4 - 6	Light blue	HI 4 - 6
15. <u>Stephania bernandifolia</u>	Skyblue Blue Dark violet	0.25 0.32 0.38	-	-	-	1)Light yellow 2)Light blue 3)Light green 4)Dark violet	EF 1 - 2 GH 1 - 2 GH 4 - 6 GI 6 - 7	Light yellow Light blue Light green Dark yellow	EF 1 - 2 GH 1 - 2 GH 4 - 6 GI 6 - 7
16. <u>Tinospora cordifolia</u>	Light blue run Light green Green tint Light yellow Light yellow	0.10-0.50 0.58 0.74 0.80 0.85	-	-	-	1)Light yellow 2)Water green 3)Yellow fluor. 4)Violet 5)Violet	HI 1 - 2 FH 2 - 5 GI 4 - 6 HI 4 - 6 GH 7 - 8	Light yellow Water green Yellow fluor. Dark violet Dark violet	HI 1 - 2 Ph 2 - 5 GI 4 - 6 HI 4 - 6 GH 7 - 8
17. <u>Cocculus macrocarpus</u>	Light grey run Light green Light violet Dark violet	0.05-0.35 0.40 0.65 0.75	Middle Buff Green fluor.	0.05 0.65	-	1)Yellowish brown 2)Violet 3)Yellow 4)Yellow	GI 1 - 2 GH 2 - 7 HI 6 - 7 HI 4 - 7	Yellowish brown Violet Yellow Yellow	GI 1 - 2 GH 2 - 7 HI 6 - 7 HI 4 - 7
18. <u>Maesa indica</u>	Light green	1.00	Green fluoro. Yellowish orange	0.60 0.9	-	1)Fluor. light blue 2)Blue tint 3)Dark violet	AB 1 - 3 GH 7 - 8 EG 3 - 4	Fluor. yellowish green Blue tint Dark yellow	AB 1 - 3 GH 7 - 8 EG 3 - 4

Contd..

Table-11 continued...

1	2	3	4	5	6	7	9	10
19. <u>Canajera rheedii</u>	Light grey	0.55	Middle buff	0.85	1)Light blue	GH 1 - 2	Light blue	GH 1 - 2
					2)Orange	GH 6 - 7	Orange	BH 6 - 7
					3)Light blue	FG 4 - 7	Light blue	FG 4 - 7
					4)Light blue	AB 8 - 9	Light blue	AB 8 - 9
20. <u>Ixora parviflora</u>	Light violet	0.16	Yellowish orange	0.40	1)Light yellow	HI 0 - 2	Light yellow	HI 0 - 2
	Light violet	0.55			2)Light yellow	GI 1 - 2	Light yellow	GI 1 - 2
					3)Violet	GH 4 - 5	Dark violet	GH 4 - 5
					4)Light yellow	EH 6 - 9	Light yellow	EH 6 - 9
					5)Light blue	FH 6 - 7	Light blue	FH 6 - 7
					6)Light blue	FH 1 - 2	Light blue	FH 1 - 2
21. <u>Paederia foetida</u>	Light green	0.90	-	-	1)Bright violet	AB 0 - 2	Bright violet	AB 0 - 2
					2)Light yellow	GI 1 - 2	Light yellow	GI 1 - 2
					3)Light blue	FH 3 - 6	Light blue	FH 3 - 6
					4)Light yellow	GH 6 - 7	Light yellow	GH 6 - 7
22. <u>Glycosmis pentaphylla</u>	Light blue	0.90	-	-	1)Midsummer	EG 1 - 2	Dark yellow	EG 1 - 2
23. <u>Citrus medica</u>	Dark violet	0.27	-	-	1)Yellow fluor.	FI 0 - 3	Yellow fluor	FI 0 - 3
	Light violet	0.60			2)Bluish green	FI 1 - 5	Bluish green?	FI 1 - 5
	Light violet	0.73			3)Blue tint	FH 4 - 6	Blue tint	FH 4 - 6
					4)Light yellow	GH 5 - 7	Light yellow	GH 5 - 7
					5)Dark violet	FG 6 - 7	Dark yellow	FG 6 - 7
					6)Violet tint	FH 7 - 8	Violet tint	FH 7 - 8
					7)Light blue	OC 7 - 9	Light blue	OC 7 - 9
					8)Blue tint	OC 5 - 6	Blue tint	OC 5 - 6

Contd..

Table-11 continued...

1	2	3	4	5	6	7	8	9	10
24. <u>Lygodium flexuosum</u>	Blue		1.00	Green	0.20	1)Light yellowish green	FG 1 - 2	Light yellowish green	FG 1 - 2
				Green	0.42	2)Light blue	FG 1 - 5	Light blue	FG 1 - 5
						3)Light yellow	AB 0 - 2	Light yellow	AB 0 - 2
						4)Light blue	DE 6 - 7	Light blue	DE 6 - 7
						-	-	5)Light yellow	EG 6 - 8
25. <u>Grewia microcos</u>	-		-	Middle buff	0.70	1)Dark violet	OB 0 - 1	Dark yellow	OB 0 - 1
						2)Light blue	FG 1 - 2	Light blue	FG 1 - 2
						3)Yellow	GH 1 - 2	Yellow	GH 1 - 2
						4)Yellow	GH 1 - 2	Yellow	GH 1 - 2
						5)Yellow	GH 1 - 2	Yellow	GH 1 - 2
						6)Blue	GH 1 - 5	Blue	GH 1 - 5
						7)Blue	GI 5 - 7	Blue	GI 5 - 7
26. <u>Vitex negundo</u>	-		-	-	-	1)Green	FI 0 - 2	Green	FI 0 - 2
						2)Blue	GH 3 - 5	Blue	GH 3 - 5
27. <u>Curcuma zedoaria</u>	Violet		0.85	-	-	1)Bright yellow	BI 1 - 2	Bright yellow	BI 1 - 2
	Violet		0.93			2)Brown	HI 1 - 2	Brown	HI 1 - 2
						3)Light green	HI 2 - 4	Light green	HI 2 - 4
						4)Blue tint	HI 4 - 6	Blue tint	HI 4 - 6
						5)Light yellow	FG 1 - 2	Light yellow	FG 1 - 2
28. <u>Kaempferia rotunda</u>	Light yellow		0.95	- -	-	1)Yellow tint	GH 1 - 2	Yellow tint	GH 1 - 2
						2)Yellow tint	GH 1 - 2	Yellow tint	GH 1 - 2
						3)Yellow tint	GH 2 - 3	Yellow tint	GH 2 - 3
						4)Light yellow	EF 1 - 2	Light yellow	EF 1 - 2
						5)Light yellow	FG 1 - 2	Light yellow	FG 1 - 2
						6)Light yellow	FG 2 - 3	Light yellow	FG 2 - 3
						7)Light blue	GH 6 - 8	Light blue	GH 6 - 8

Contd...

T A B L E - 12

TLC study of methanolic extracts of seeds using ethyl acetate : formic acid and water (80:10:10) as developing solvent and boric acid - oxalic acid as spray reagent.

Two dimensional paper chromatographic study of methanolic extract of seeds using tertiary butanol: glacial acetic acid : water (3 : 1 : 1) for first run and 1% glacial acetic acid for second run and detection of spots by exposure to ammonia vapours.

S.No.	Name of the drug	UV without spray		UV with spray		UV without spray		UV with ammonia vapours	
		Colour	Rf	Colour	Rf	Colour	Location	Colour	Location
1	2	3	4	5	6	7	8	9	10
1.	<u>Ricinus communis</u>	-	-	-	-	1)Light blue 2)Light blue	GH 1 - 2 GH 4 - 6	Light blue Light blue	GH 1 - 2 GH 4 - 6
2.	<u>Hydnocarpus wightiana</u>	-	-	-	-	-	-	-	-
3.	<u>Cassia tora</u>	Dark violet Yellowish green Dark violet	0.25 0.52 0.96	-	-	1)Yellow 2)Grey 3)Grey 4)Light Blue 5)Dark violet 6)Light yellow 7)Green 8)Light orange -	GI 1 - 2 GI 1 - 3 GH 4 - 6 GH 5 - 7 BG 7 - 8 CE 6 - 8 BF 4 - 6 EG 5 - 6 -	Dark yellow Grey Grey Light blue Dark yellow Light yellow Green Dark orange Light blue	GI 1 - 2 GI 1 - 3 GH 4 - 6 GH 5 - 7 BG 7 - 8 CE 6 - 8 BF 4 - 6 EG 5 - 6 AC 8 - 9
4.	<u>Strychnos nux-vomica</u>	Light grey run	0-1.00	Middle buff Middle buff	0.65 0.80	1)Grey 2)Light blue	OA 0 - 1 DF 0 - 1	Grey Light blue	OA 0 - 1 DF 0 - 1

T A B L E - 13

TLC study of methanolic extract of leaves using ethyl acetate, formic acid and water (80:10:10) as developing solvent and boric acid-oxalic acid as spray reagent.

Two dimensional paper chromatographic study of methanolic extract of leaves using tertiary butanol : glacial acetic acid : water (3 : 1 : 1) for first run and 1% glacial acetic acid for second run and detection of spots by exposure to ammonia vapours.

S.No.	Name of the drug	UV without spray		UV with spray		UV without spray		UV with ammonia exposure	
		Colour	Rf	Colour	Rf	Colour	Location	Colour	Location
1	2	3	4	5	6	7	8	9	10
1.	<u>Adhatoda vasica</u>	Light blue Light blue	0.37 0.90	-	-	1)Light yellow 2)Light violet 3)Yellowish violet 4)Light blue 5)Grey 6)Grey -	HI 1 - 2 GI 1 - 2 FG 1 - 3 FH 4 - 5 EG 6 - 7 DF 4 - 6 -	Dark yellow Light violet Yellowish violet Light blue Grey Grey 7)Light blue	HI 1 - 2 GI 1 - 2 FG 1 - 3 FH 4 - 5 EG 6 - 7 DF 4 - 6 BC 1 - 3
2.	<u>Andrographis paniculata</u>	Yellowish green fluor.	0.97	-	-	1)Yellowish green 2)Light blue	HI 1 - 2 HI 2 - 5	Pink Light blue	HI 1 - 2 HI 2 - 5
3.	<u>Annona squamosa</u>	Light blue Light green Light violet Light green	0.1 0.2 0.7 0.82	Dark green	0.85	1)Flesh tint 2)Light yellow 3)Light green 4)Light green 5)Light green 6)Light violet	EG 0 - 2 FG 0 - 1 EF 2 - 5 FG 6 - 8 FG 7 - 8 DE 8 - 9	Flesh tint Light yellow Light green Light green Light green Light violet	EG 0 - 2 FG 0 - 1 EF 2 - 5 FG 6 - 8 FG 7 - 8 DE 8 - 9

Contd.:

Table-43 continued...

1	2	3	4	5	6	7	8	9	10
4.	<u>Calotropis gigantea</u>	Light blue run	0-0.55	-	-	1)Blue	FH 1 - 2	Blue	FH 1 - 2
		Light violet	0.85			2)Yellow	HI 1 - 3	Fluor. yellow	HI 1 - 3
		Light green	0.9			3)Light green	HI 4 - 5	Light green	HI 4 - 5
						4)Light blue	HI 4 - 5	Light blue	HI 4 - 5
						5)Light violet	FG 6 - 7	Dark violet	FG 6 - 7
5.	<u>Croton oblongifolius</u>	Light violet	0.45	-	-	1)Yellow	EH 1 - 2	Yellow	EH 1 - 2
						2)Blue	EF 3 - 6	blue	EF 3 - 6
						3)Light yellow	FH 6 - 8	Light yellow violet	FH 6 - 8
						4)Light violet	EG 7 - 8	Light violet	EG 7 - 8
6.	<u>Ricinus communis</u>	Light green	0.9	-	-	1)Light yellow	GH 0 - 1	Light yellow	GH 0 - 1
						2)Light yellow	GH 1 - 2	Light yellow	GH 1 - 2
						3)Light blue	GH 4 - 6	Light blue	GH 4 - 6
						4)Light violet	DE 7 - 8	Light violet	DE 7 - 8
						-	-	5)Light yellow	EG 6 - 7
7.	<u>Leucas aspera</u>	Light blue	0.73	-	-	1)Brown	HI 1 - 2	Brown	HI 1 - 2
		Light violate	0.90			2)Brown	HI 2 - 3	Brown	HI 2 - 3
		Light green	0.97			3)Light blue	GH 4 - 5	Light blue	GH 4 - 5
						4)Light green	HI 4 - 6	Light green	HI 4 - 6
8.	<u>Pterocarpus margupium</u>	-	-	-	-	1)Brown	HI 1 - 2	Brown	HI 1 - 2

Contd...

Table-13 continued...

1	2	3	4	5	6	7	8	9	10
9.	<u>Tamprindus indica</u>	-	-	Light green	0.1	1)Yellowish brown 2)Midsummer 3)Light blue 4)Grey 5)Grey 6)Light green	HI 1 - 2 HI 2 - 3 GH 2 - 3 EG 3 - 5 GI 4 - 6 HI 6 - 7	Yellowish brown Midsummer Light blue Grey Grey Light green	HI 1 - 2 HI 2 - 3 GH 2 - 3 EG 3 - 5 GI 4 - 6 HI 6 - 7
10.	<u>Cassia fistula</u>	Light grey Light green Light orange	0.85 0.95 1.00	-	-	1)Yellowish grey 2)Light yellow 3)Light violet 4)Light green 5)Light orange 6)Light blue 7)Light blue	GI 1 - 2 GH 2 - 4 FH 5 - 6 EF 5 - 6 GH 6 - 7 HI 6 - 7 FH 7 - 8	Yellowish grey Light yellow Light violet Light green Light orange Light blue Light blue	GI 1 - 2 GH 2 - 4 FH 5 - 6 EF 5 - 6 GH 6 - 7 HI 6 - 7 FH 7 - 8
11.	<u>Mimosa pudica</u>	-	-	-	-	1)Light blue 2)Light blue 3)Orange brown 4)Light green 5)Light brown	BD 1 - 2 DE 1 - 2 FI 0 - 2 FH 2 - 7 EG 6 - 7	Light blue Light blue Orange brown Light green Light brown	BD 1 - 2 DE 1 - 2 FI 0 - 2 FH 2 - 7 EG 6 - 7
12.	<u>Atylosia scarabaeoides</u>	Grey Grey	0.8 0.9	-	-	1)Flesh tint 2)Light grey 3)Light grey	HI 1 - 3 CE 2 - 4 EG 3 - 5	Flesh tint Light grey Light grey	HI 1 - 3 CE 2 - 4 EG 3 - 5

Contd...

Table-13 continued...

1	2	3	4	5	6	7	8	9	10
13.	<u>Thespesia populnea</u>	-	-	-	-	1)Light blue 2)Biscuit tint 3)Light green 4)Violet	EF 1 - 2 FH 1 - 2 FH 3 - 7 DE 7 - 8	Light blue Biscuit tint Light green Violet	EF 1 - 2 FH 1 - 2 FH 3 - 7 DE 7 - 8
14.	<u>Abutilon indicum</u>	-	-	-	-	1)Biscuit tint 2)Light blue 3)Light blue 4)Light blue	HI 1 - 2 HI 3 - 5 EG 6 - 7 CD 8 - 9	Biscuit tint Light blue Light blue Light blue	HI 1 - 2 HI 3 - 5 EG 6 - 7 CD 8 - 9
15.	<u>Hibiscus</u> <u>rosa-sinensis</u>	Light grey Light grey Light grey	0.45 0.7 0.9	Green fluor. Green fluor. Light green	0.25 0.55 0.84	1)Light grey 2)Light grey 3)Light blue 4)Light yellow	FG 3 - 4 GI 5 - 7 DE 4 - 6 EF 6 - 7	Light grey Light grey Light blue Light yellow	FG 3 - 4 GI 5 - 7 DE 4 - 6 EF 6 - 7
16.	<u>Tinospora cordifolia</u>	-	-	-	-	1)Light blue 2)Light orange	GI 4 - 6 HI 0 - 1	Light blue Light orange	GI 4 - 6 HI 0 - 1
17.	<u>Eugenia jambolana</u>	Light grey	0.82	-	-	1)Greyish brown 2)Light green 3)Light blue 4)Light violet	AB 1 - 5 CG 1 - 2 EF 2 - 3 FH 2 - 3	Greyish brown Light green Light blue Light violet	AB 1 - 5 CG 1 - 2 EF 2 - 3 FH 2 - 3

Contd...

Table-13 continued...

1	2	3	4	5	6	7	8	9	10
18.	<u>Boerhaavia diffusa</u>	Light grey Light blue run Light violet	0.1 0.2-0.7 0.75	Midsummer	0.05	1)Yellow 2)Yellow 3)Violet 4)Light green 5)Light yellow	EG 1 - 2 GH 2 - 3 EF 2 - 4 EG 5 - 8 FH 7 - 9	Yellow Yellow Violet Light green Dark yellow	EG 1- 2 GH 2 - 3 EF 2 - 4 EG 5 - 8 FH 7 - 9
19.	<u>Nyctanthes arbor-tristis</u>	Light grey	0.4	Green	1.00	1)Flesh tint 2)Flesh tint 3)Blue tint 4)Light yellow 5)Light violet	OA 1 - 3 AB 1 - 3 CG 2 - 4 DF 2 - 3 HI 4 - 5	Flesh tint Flesh tint Blue tint Light yellow Light violet	OA 1 - 3 AB 1 - 3 CG 2 - 4 DF 2 - 3 HI 4 - 5
20.	<u>Averrhoa bilimbi</u>	Light blue run Grey	0-1 0.85	Light green run	0.3-1	1)Light green 2)Dark blue 3)Biscuit tint 4)Light yellow 5)Orange 6)Greenish yellow	CD 1 - 2 DE 1 - 2 FI 1 - 3 DE 4 - 5 GH 6 - 7 FH 4 - 6	Dark green Dark blue Biscuit tint Light yellow Orange Greenish yellow	CD 1 - 2 DE 1 - 2 FI 1 - 3 DE 4 - 5 GH 6 - 7 FH 4 - 6
21.	<u>Oldenlandia corymbosa</u>	-	-	Mashroom tint	0.9	1)Yellow 2)Asian blue 3)Light yellowish grey 4)Light violet 5)Light violet 6)Light violet	FH 1 - 2 FG 3 - 5 FG 5 - 7 DG 7 - 8 EG 6 - 8 EF 8 - 9	Yellow Asian blue Light yellowish grey Light violet Light violet Light violet	FH 1 - 2 FG 3 - 5 FG 5 - 7 DG 7 - 8 EG 6 - 8 EF 8 - 9

Contd...

Table-13 continued...

1	2	3	4	5	6	7	8	9	10
22.	<u>Psychotria truncata</u>	Light violet	0.5	Green fluor.	0.05	1)Orange	GH 1 - 2	Orange	GH 1 - 2
				Light green	0.34	2)Orange	GH 1 - 2	Orange	GH 1 - 2
				Green fluor.	0.85	3)Orange	GH 2 - 3	Orange	GH 2 - 3
						4)Light grey	GH 4 - 5	Light yellow	GH 4 - 5
						5)Light grey	DE 5 - 6	Light yellow	DE 5 - 6
						6)Midsummer	GH 5 - 6	Light yellow	GH 5 - 6
						7)Light orange	DF 7 - 8	Blue	DF 7 - 8
23.	<u>Murraya koenigii</u>	Light blue run	0-0.65	-	-	1)Grey	EH 0 - 1	Grey	EH 0 - 1
		Light green	0.75			2)Light blue	FH 1 - 4	Light blue	FH 1 - 4
24.	<u>Mimusops kauki</u>	Greyish green	0.8	-	-	1)Flemingo tint	EI 0 - 1	Flemingo tint	EI 0 - 1
						2)Light yellowish green	GH 5 - 8	Light yellowish green	GH 5 - 8
						3)Light green	EF 5 - 6	Light green	EF 5 - 6
						4)Light violet	EG 8 - 9	Light violet	EG 8 - 9
						5)Grey	FH 4 - 5	Grey	FH 4 - 5
25.	<u>Datura metel</u>	Light blue	0.3	Green fluor.	0.05	1)Flesh tint	DG 0 - 2	Flesh tint	DG 0 - 2
		Light grey	0.7			2)Light green	HI 0 - 1	Light green	HI 0 - 1
		Midsummer	0.85			3)Yellow orange	DF 3 - 5	Yellow orange	DF 3 - 5
		Light grey	0.92			4)Yellow green	DF 4 - 6	Yellow green	DF 4 - 6
						5)Yellow green	EF 6 - 7	Yellow green	EF 6 - 7
						6)Light blue	HI 5 - 6	Light blue	HI 5 - 6

Contd...

Table-13 continued...

1	2	3	4	5	6	7	8	9	10
26. <u>Grewia microcos</u>	Grey	0.4	Green flour.	0.35	1)Light green	EF 0 - 2	Light green	EF 0 - 2	
	Grey blackish	1.00			2)Light blue	HI 1 - 2	Light blue	HI 1 - 2	
					3)Brown	EF 2 - 4	Brown	EF 2 - 4	
					4)Light blue	FH 3 - 4	Light blue	FH 3 - 4	
					5)Light green	GH 4 - 5	Light green	GH 4 - 5	
					6)Ultra-blue	EG 4 - 6	Ultra-blue	EG 4 - 6	
					-	-	7)Light pink	FH 6 - 7	
27. <u>Lantana camara</u>	Light blue	0.35	-	-	1)Biscuit tint	HI 0 - 2	Biscuit tint	HI 0 - 2	
	Light blue	0.64			2)Grey	GH 5 - 7	Grey	GH 5 - 7	
					3)Blue	GH 7 - 8	Blue	GH 7 - 8	
					4)Light green	EI 7 - 9	Light green	EI 7 - 9	
28. <u>Cymbopogon citratus</u>	-	-	-	-	1)Yellow	GH 1 - 2	Yellow	GH 1 - 2	
					2)Light blue	GH 3 - 5	Light blue	GH 3 - 5	

T A B L E - 14

TLC study of methanolic extracts of barks, using ethyl acetate : formic acid and water (80 : 10 : 10) as developing solvent and boric acid-oxalic acid as spray reagent.

Two dimensional paper chromatographic study of methanolic extracts of barks using tertiary butanol : glacial acetic acid : water (3 : 1 : 1) for first run and 15% glacial acetic acid for second run and detection of spots by exposure to ammonia vapours.

S.No.	Name of the drug	UV without spray		UV with spray		UV without spray		UV with ammonia exposure	
		Colour	Rf	Colour	Rf	Colour	Location	Colour	Location
1	2	3	4	5	6	7	8	9	10
1.	<u>Spondius pinnata</u>	Light blue	0.98	-	-	1)Yellow	HI 1 - 2	Pale yellow violet	HI 1 - 2
						2)Yellow	HI 1 - 2	Yellow	HI 1 - 2
						3)Yellow	HI 1 - 2	Yellowish green	HI 1 - 2
						4)Dark violet	HI 4 - 6	Dark violet	HI 4 - 6
						5)Light blue	GH 4 - 5	Light blue	GH 4 - 5
						6)Orange	HI 6 - 7	Orange	HI 6 - 7
						7)Orange	HI 7 - 8	Orange	HI 7 - 8
2.	<u>Annona squamosa</u>	Light blue	0.17	-	-	1)Light mushroom tint	DG 4 - 5	Light mushroom tint	DG 4 - 5
		Light grey	0.55	-	-	2)Light violet	GH 4 - 6	Light violet	GH 4 - 6
		Light yellowish green	0.95						
3.	<u>Polyalthea fragrans</u>	Light blue	0.14	Blue	0.12	1)Brown	EH 1 - 2	Brown	EH 1 - 2
		Light yellow	0.3			2)Dark blue	FH 1 - 2	Dark blue	FH 1 - 2
		Light yellow	0.37			3)Dark violet	EG 4 - 7	Greenish violet	EG 4 - 7
		Light green	0.43			4)Greenish yellow	FH 5 - 8	Greenish yellow	FH 5 - 8
		Violet	0.48			-	-	5)Light violet	DF 2 - 3
		Green	0.55						
		Light green	0.90						

Contd...

Table-14 continued...

1	2	3	4	5	6	7	8	9	10
4.	<u>Holarrhena antidysenterica</u>	-	-	-	-	1)Light blue 2)Light blue 3)Blue 4)Light green 5)Light green	HI 1 - 2 HI 1 - 2 GH 5 - 6 GH 6 - 7 GH 6 - 7	Light blue Light blue Blue Light green Light green	HI 1 - 2 HI 1 - 2 GH 5 - 6 GH 6 - 7 GH 6 - 7
5.	<u>Oroxylum indicum</u>	-	-	-	-	1)Light yellow 2)Blackish brown 3)Violet 4)Blackish brown 5)Blackish brown 6)Midsummer 7)Light green	HI 1 - 2 GI 0 - 3 FH 5 - 7 GH 3 - 4 DG 3 - 5 FG 6 - 7 GH 7 - 8	Light yellow Blackish brown Violet Blackish brown Blackish brown Midsummer Dark green	HI 1 - 2 GI 0 - 3 FH 5 - 7 GH 3 - 4 DG 3 - 5 FG 6 - 7 GH 7 - 8
6.	<u>Croton oblongifolius</u> Green fluor.		0.98	-	-	1)Yellow 2)Yellow 3)Light blue 4)Light blue	GH 1 - 2 GH 1 - 2 HI 3 - 5 FG	Yellow Yellow Light blue Light blue	GH 1 - 2 GH 1 - 2 HI 3 - 5
7.	<u>Ricinus communis</u>	-	-	-	-	1)Light yellow 2)Light yellow 3)Light yellow 4)Light yellow 5)Light blue	GH 0 - 1 GH 0 - 1 GH 1 - 2 GH 1 - 2 GH 2 - 5	Light yellow Light yellow Light yellow Light yellow Light blue	GH 0 - 1 GH 0 - 1 GH 1 - 2 GH 1 - 2 GH 2 - 5

Contd...

Table-14 continued...

1	2	3	4	5	6	7	8	9	10
8.	<u>Hydnocarpus wightiana</u> Craven		0.8	-	-	1)Light yellow 2)Bluish green 3)Light violet 4)Light blue	GH 0 - 1 FG 4 - 6 GH 5 - 7 GH 7 - 9	Light yellow Bluish green Light violet Light blue	GH 0 - 1 FG 4 - 6 GH 5 - 7 GH 7 - 9
9.	<u>Macbilus macrantha</u>	Light blue Light yellow	0.27 0.95	-	-	1)Yellow	HI 1 - 2	Yellow	HI 1 - 2
10.	<u>Pterocarpus marsupium</u>	Light green	0.74	-	-	1)Light yellow 2)Light yellow 3)Light yellow 4)Light yellow 5)Light blue 6)Light blue	HI 0 - 1 HI 0 - 1 HI 0 - 1 HI 1 - 2 HI 2 - 4 GH 4 - 6	Light yellow Light yellow Light yellow Light yellow Light blue Light blue	HI 0 - 1 HI 0 - 1 HI 0 - 1 HI 1 - 2 HI 2 - 4 GH 4 - 6
11.	<u>Tamarindus indica</u>	-	-	-	-	1)Light blue 2)Bluish green 3)Midsummer 4)Light blue	HD 1 - 2 GH 1 - 2 GI 1 - 3 -	Light blue Bluish green Midsummer Light blue	HD 1 - 2 GH 1 - 2 GI 1 - 3 HI 5 - 6
12.	<u>Cassia fistula</u>	Brown run.	0.65-1.00	Light choco- late run.	0-1.00	1)Blackish brown 2)Light blue 3)Midsummer 4)Midsummer	PH 0 - 2 GH 1 - 3 GI 2 - 3 GH 4 - 6	Blackish brown Light blue Midsummer Midsummer	PH 0 - 2 GH 1 - 3 GI 2 - 3 GH 4 - 6

Contd...

Table-14 continued...

1	2	3	4	5	6	7	8	9	10
13.	<u>Moringa pterygosperma</u>	-	-	-	-	1)Yellow 2)Light yellow 3)Light violet	HI 1 - 2 GH 5 - 6 HI 5 - 6	Yellow Light yellow Dark violet	HI 1 - 2 GH 5 - 6 HI 5 - 6
14.	<u>Eucalyptus globulus</u>	Light blue	0.85	-	-	1)Light blue 2)Light green	GH 5 - 6 FG 4 - 5	Light blue Light green	GH 5 - 6 FG 4 - 5
15.	<u>Careva arborea</u>	-	-	-	-	1)Blue	HI 3 - 4	Blue	HI 3 - 4
16.	<u>Nyctanthes arbor-tristis</u>	-	-	-	-	1)Light blue 2)Violet blue	HI 5 - 6 GH 5 - 6	Light blue Violet blue	HI 5 - 6 GH 5 - 6
17.	<u>Zizyphus rugosa</u>	-	-	-	-	1)Light blue 2)Light blue	GH 1-2 GH 2 - 3	Light blue Light blue	GH 1 - 2 GH 2 - 3
18.	<u>Zizyphus jujuba</u>	-	-	-	-	1)Violet fluor.	BF 0 - 2	Violet fluor.	BF 0 - 2
19.	<u>Psychotria truncata</u>	-	-	Green	1.00	1)Light blue 2)Light green 3)Light blue	CF 1 - 3 GH 1 - 3 AB 2 - 8	Light blue Light green Light blue	CF 1 - 3 GH 1 - 3 AB 2 - 8

Contd...

Table-14 continued...

1	2	3	4	5	6	7	8	9	10
20.	<u>Zanthoxylum rhetsa</u>	Light blue Light violet Light green Yellowish green fluor.	0.2 0.65 0.83 0.5	Dark green	0.9	1)Violet 2)Greenish yellow 3)Yellow 4)Dark green	EH 1 - 3 AF 2 - 3 DH 2 - 5 EI 4 - 7	Violet Greenish yellow Yellow Dark green	EH 1 - 3 AF 2 - 3 DH 2 - 5 EI 4 - 7
21.	<u>Allophylus cobbe</u>	-	-	Grey Grey	0.35 0.75	1)Yellow 2)Yellow 3)Orange 4)Orange 5)Dark blue 6)Yellowish orange 7)Orange 8)Orange	GH 1 - 2 GH 1 - 2 GH 1 - 3 GH 3 - 4 FG 4 - 5 GH 5 - 7 GH 7 - 8 GH 8 - 9	Yellow Yellow Orange Orange Dark blue Yellowish orange Orange Orange	GH 1 - 2 GH 1 - 2 GH 1 - 3 GH 3 - 4 FG 4 - 5 GH 5 - 7 GH 7 - 8 GH 8 - 9
22.	<u>Mimusops elengi</u>	-	-	-	-	1)Light purple 2)Bluish green 3)Light violet	AC 1 - 2 GI 1 - 2 GH 6 - 8	Light purple Bluish green Light violet	AC 1 - 2 GI 1 - 2 GH 6 - 8
23.	<u>Helicteres isora</u>	-	-	-	-	1)Violet 2)Yellow	DF 1 - 2 GH 1 - 2	Violet Yellow	DF 1 - 2 GH 1 - 2
24.	<u>Sterculia urens</u>	-	-	-	-	1)Dark violet	GH 3 - 5	Dark violet	GH 3 - 5

Contd...

Table-14 continued...

1	2	3	4	5	6	7	8	9	10
25. <u>Grewia microcos</u>	Light blue	0.25	-	-	-	1)Light green	AB 2 - 3	Dark green	AB 2 - 3
	Light violet	0.42				2)Light blue	HI 4 - 5	Light blue	HI 4 - 5
	Light violet	0.68				3)Light violet	FG 4 - 6	Light violet	FG 4 - 6
	Green	0.80				4)Light green	FG 7 - 8	Dark green	FG 7 - 8
26. <u>Ficus bengalensis</u>	Light violet	0.6	Blue	1.00		1)Light purple	AD 1 - 2	Light purple	AD 1 - 2
						2)Light blue	EG 1 - 2	Light blue	EG 1 - 2
						3)Light yellow	HI 1 - 2	Light yellow	HI 1 - 2
						4)Dark blue	HI 5 - 7	Dark blue	HI 5 - 7
						-	-	5)Light green	HI 7 - 8
27. <u>Vitex negundo</u>	-	-	-	-	-	1)Yellowish brown	AE 0 - 2	Yellowish brown	AE 0 - 2
						2)Yellowish brown	FI 1 - 2	Yellowish brown	FI 1 - 2
						3)Light violet	GH 2 - 4	Light violet	GH 2 - 4
						4)Dark green	GI 4 - 7	Dark green	GI 4 - 7
28. <u>Gmelina arborea</u>	Green fluor.	0.97	Dark green fluor.	0.97		1)Dark violet	AC 1 - 4	Dark violet	AC 1 - 4
						2)Yellow	AB 1 - 2	Yellow	AB 1 - 2
						3)Dark green	BG 1 - 5	Dark green	BG 1 - 5
						4)Violet	EH 1 - 2	Violet	EH 1 - 2

CHAPTER VI  
MICROCHEMICAL TESTS FOR THE CONSTITUENTS  
OF THE MEDICINAL PLANTS

C H A P T E R VIMICROCHEMICAL TEST FOR THE CONSTITUENTS OF THE MEDICINAL PLANTS

The plant kingdom holds many species of plants containing substances of medicinal value which have yet to be discovered. All the chemical compounds elaborated by plants are not of equal interest to the Pharmacognocist. The so-called active principles are frequently alkaloids, glycosides, tannins and flavonoids and these therefore, deserve special attention. Phytochemical screening of plants for therapeutically and industrially important compounds like tannins, glycosides, flavonoids & alkaloids provides valuable clues for pharmacological evaluation and discovery of new drugs, besides helping in the discovery of new plant sources of these active compounds.

As far as Goa region is concerned, there is no phytochemical screening of the plants grown in Goa, reported so far. Considering the medicinal use of these plants grown in Goa, phytochemical screening of these plants was done in respect of the constituents like alkaloids, anthraquinone glycosides, tannins, phenols & flavonoids.

The results are given in Table - 15.

T A B L E - 15

PHYTOCHEMICAL SCREENING OF SOME PLANTS FROM GOA

S.No.	Botanical name	Plant part	Alkaloids		Anthraquinone glycosides		Tannins		Phenols	Flavonoids
			(a)	(b)	(c)	(d)	(e)	(f)		
1	2	3	4	5	6	7	8	9	10	11
1.	<u>Boerhaavia diffusa</u>	Herb	+	+	-	-	-	-	-	-
2.	<u>Momordica dioica</u>	Root	+	+	-	-	-	-	-	-
3.	<u>Viburnum foetidum</u>	Root	+	+	-	+	+	+	+	-
4.	<u>Mimusops elengi</u>	Bark	+	+	-	+	+	+	+	-
5.	<u>Mimusops kauki</u>	Leaf	-	-	+	+	+	+	+	+
6.	<u>Rauwolfia serpentina</u>	Root	+	+	-	-	-	-	-	-
7.	<u>Holarrhena antidysenterica</u>	Bark	+	+	-	-	+	+	+	-
8.	<u>Calotropis gigantea</u>	Leaf	-	-	+	+	+	+	+	-
9.	<u>Hemidesmus indicus</u>	Root	-	-	-	-	+	+	-	-
10.	<u>Strychnos nux-vomica</u>	Seed	+	+	-	-	-	-	-	-
11.	<u>Ixora parviflora</u>	Root	-	-	-	-	+	+	+	+
12.	<u>Oldenlandia corymbosa</u>	Herb	-	-	-	-	-	-	-	-
13.	<u>Psychotria truncata</u>	Bark	-	-	-	-	+	+	+	+
		Leaf	+	+	-	+	-	-	-	-
14.	<u>Paederia foetida</u>	Root	-	-	+	+	-	-	-	-
15.	<u>Croton oblongifolius</u>	Bark	-	-	-	-	-	-	+	-
		Leaf	+	+	-	+	+	+	+	-
		Root	+	+	-	-	-	-	-	-

Contd...

Table-15 continued...

1	2	3	4	5	6	7	8	9	10	11
16.	<u>Ricinus communis</u>	Bark	-	-	-	-	-	-	-	-
		Seed	+	+	-	-	-	-	-	-
		Leaf	-	-	+	+	-	-	-	-
17.	<u>Averrhoa bilimbi</u>	Leaf	-	-	-	-	-	-	-	-
18.	<u>Annona squamosa</u>	Bark	-	-	+	+	-	-	+	-
		Leaf	+	+	+	+	+	+	+	-
19.	<u>Polyalthia fragrans</u>	Bark	-	-	-	-	+	+	+	+
20.	<u>Machilus macrantha</u>	Bark	-	-	-	-	+	+	+	-
21.	<u>Thespesia populnea</u>	Leaf	+	+	+	+	+	+	+	-
22.	<u>Abutilon indicum</u>	Leaf	-	-	-	-	-	-	-	-
23.	<u>Hibiscus rosa-sinensis</u>	Leaf	+	+	-	-	-	-	-	-
24.	<u>Helicteres isora</u>	Bark	-	-	-	-	-	-	-	-
25.	<u>Sterculia urens</u>	Bark	+	+	+	+	+	+	+	+
26.	<u>Grewia microcos</u>	Bark	-	-	-	-	-	-	-	-
		Leaf	+	+	-	-	-	-	-	-
		Root	-	-	-	+	-	-	-	-
27.	<u>Nyctanthes arbor-tristis</u>	Bark	T	T	-	-	-	-	+	-
		Leaf	+	+	+	+	-	-	+	T
28.	<u>Eugenia jambolana</u>	Leaf	-	-	-	-	-	-	-	-
29.	<u>Eucalyptus globulus</u>	Bark	-	-	-	-	-	-	-	T
30.	<u>Careya arborea</u>	Bark	-	-	-	-	+	+	+	+
31.	<u>Capparis zeylanica</u>	Root	+	+	-	-	-	-	-	-
32.	<u>Moringa pterocarpa</u>	Bark	-	-	-	-	-	-	-	+
33.	<u>Hydnocarpus wightiana</u>	Seed	+	+	-	-	-	-	-	-
		Bark	+	+	-	-	-	-	+	T

Contd...

Table-15 continued..

1	2	3	4	5	6	7	8	9	10	11
34.	<u>Casearia esculenta</u>	Root	-	-	-	-	+	+	+	+
35.	<u>Maesa indica</u>	Root	+	+	-	-	+	+	+	+
36.	<u>Zizyphus rugosa</u>	Bark	+	+	-	-	-	-	-	T
37.	<u>Zizyphus jujuba</u>	Bark	+	+	+	+	-	-	+	+
38.	<u>Stephania hernandifolia</u>	Root	-	-	-	-	-	-	-	-
39.	<u>Tinospora cordifolia</u>	Leaf	+	+	-	-	-	-	-	+
		Root	-	-	-	-	-	-	-	+
40.	<u>Cocculus macrocarpus</u>	Root	+	+	-	-	+	+	+	-
41.	<u>Atylosia scarabaeoides</u>	Herb	-	-	-	-	-	-	-	-
42.	<u>Pterocarpus marsupium</u>	Root	-	-	-	-	+	+	+	+
		Bark	-	-	-	-	+	+	+	+
		Leaf	+	+	+	+	-	-	-	+
43.	<u>Bamarindus indica</u>	Bark	-	-	-	-	-	-	+	+
		Leaf	+	+	-	-	-	-	+	+
44.	<u>Cassia fistula</u>	Bark	-	-	-	+	+	+	+	+
		Leaf	-	-	+	+	+	+	-	-
45.	<u>Cassia tora</u>	Seed	-	-	-	-	-	-	-	-
46.	<u>Caesalpinia crista</u>	Root	-	-	-	-	+	+	+	-
47.	<u>Mimosa pudica</u>	Leaf	+	+	-	+	-	-	-	-
48.	<u>Glycosmis pentaphylla</u>	Root	-	-	-	-	-	-	-	-
49.	<u>Citrus medica</u>	Root	+	+	-	-	+	+	-	-
50.	<u>Zanthoxylum rhetsa</u>	Bark	+	+	-	-	+	+	+	+

Contd...

Table-15 continued...

1	2	3	4	5	6	7	8	9	10	11
51.	<u>Murraya koenigii</u>	Leaf	+	+	-	-	-	-	-	-
52.	<u>Cassia rheedii</u>	Root	-	-	-	-	-	-	-	-
53.	<u>Allophylus cobbe</u>	Bark	-	-	-	-	+	+	-	-
54.	<u>Spondias pinnata</u>	Bark	-	-	-	-	+	+	-	-
55.	<u>Adhatoda vasica</u>	Root	-	-	-	-	-	-	-	-
		Leaf	+	+	+	+	-	-	-	-
56.	<u>Andrographis paniculata</u>	Herb	-	-	-	-	-	-	-	-
57.	<u>Oroxylum indicum</u>	Bark	-	-	-	-	+	+	+	+
58.	<u>Leucas aspera</u>	Root	-	-	-	-	-	-	-	-
		Leaf	-	-	-	-	+	+	+	-
59.	<u>Datura metel</u>	Leaf	+	+	-	-	-	-	-	-
60.	<u>Lantana camara</u>	Leaf	+	+	-	-	-	-	-	+
61.	<u>Vitex negundo</u>	Root	-	-	-	-	+	+	+	T
		Bark	-	-	-	-	-	-	-	-
62.	<u>Gmelina arborea</u>	Bark	+	+	+	+	+	+	+	+
63.	<u>Ficus bengalensis</u>	Bark	-	-	-	+	+	+	+	+
64.	<u>Arundinella gigantea</u>	Root	-	-	-	-	-	-	-	-
65.	<u>Cymbopogon citratus</u>	Leaf	+	+	-	-	-	-	-	-
66.	<u>Asparagus racemosus</u>	Root	-	-	-	-	-	-	-	-
67.	<u>Smilax macrophylla</u>	Root	-	-	-	-	-	-	-	-
68.	<u>Curcuma zedoaria</u>	Rhizome	+	+	+	+	+	+	-	+
69.	<u>Kaempferia rotunda</u>	Tuber	+	+	-	-	-	-	-	-
70.	<u>Lygodium flexuosum</u>	Root	-	-	-	-	-	-	-	+

+ indicates presence of the constituent.

- indicates absence of the constituent.

T indicates slight precipitate or turbidity of the constituent.

CHAPTER VII  
PHYTOCHEMICAL OBSERVATIONS ON MAESA  
INDICA WALL-A CASE STUDY

## CHAPTER VII

### PHYTOCHEMICAL OBSERVATIONS ON MAESA INDICA, Wall - A CASE STUDY

Out of 70 herbal specimen collected and screened for different pharmacognostical studies, it was found that plant named Maesa indica not reported so far is being utilised by the people in traditional indigenous system of medicine for various ailments and diseases. Chopra et al (1958) mentioned its use in Ayurveda as anthelmintic and anti-syphilitic. In Goa, the seeds of this plant are used as anthelmintic, roots are mainly used as blood purifier and also as anti-hypertensive, while leaves are used as blood purifier and as anthelmintic. The use of seeds and leaves is made from the decoction of these plant products, while in case of roots, the root is rubbed with milk or rice water and taken internally. Considering use of Maesa indica in traditional medicine, its availability in Goa and that this plant is not much worked out except few of the following reported works, its study was taken up. Atal et al (1978) reported that the whole plant excluding roots contained the tannins. Desai et al (1975) reported that the acetone extract of seeds yielded mesoquinone. Aziz Ahmad and Zaman (1973) reported that the petroleum ether extract of leaves yielded sitosterol and ethyl acetate extract of leaves gave quercetin - 3 rhamnoside. However, literature survey did not reveal any published work on the roots of Maesa indica. Considering the fact that this plant from Goa region has not been reported so far for phytochemical screening, the roots of this plant were taken for the phytochemical study considering its therapeutic value.

The roots of Maesa indica were collected in the month of October from

the forest of Morlem, Sattari Taluka, Goa. However the collection yield was poor due to the scarcity of the growth of this plant. Herbarium sheet of this plant was prepared and is kept in the Herbarium of Goa College of Pharmacy, Panaji-Goa. The identity was established through Botany Department of Chowgule College, Margao-Goa and it was further confirmed through Botanical Survey of India, Western Zone, Pune, Maharashtra.

The roots were cut into small chips and then dried on trays in drying oven at a temperature of 55°C until completely dried. The small chips were then placed in hammer mill and powdered. This coarse powder was then sieved through a sieve number 16 for obtaining uniformity in the size of the drug. The flavonoids were isolated as per the scheme given herewith:

The Scheme used for the isolation of flavonoids

removed	1 kg of powdered drug extracted with petroleum ether by soxhlet extractor.
Plant acids, fatty & waxy materials and phytosterols	
removed	Marc extracted with chloroform.
Alkaloids and other non-flavonoid substances	
removed	Marc extracted with methanol.
Flavonoid substances	
	Methanolic extract was concentrated and this concentrated extract was digested with distilled water (2 - 3 hours) two or three times and filtered through muslin.
Precipitate removed	
Water insoluble substances.	
removed	Aqueous extract extracted with solvent ether in separating funnel.
Free aglycones	

removed Flavonoid glycosides.	Aqueous extract extracted with (a) ethyl acetate. (b) ethyl acetate : methanol (95:5) (c) n - butanol
----------------------------------	--

Aqueous layer preserved.

### Isolation of flavonoids and sterols

One kg. of powdered roots of Maesa indica was placed in a thimble made of cloth and then placed in a soxhlet extractor which was connected below to the receiving flask containing few pieces of porcelain to avoid bumping and on the top with a reducing adaptor to which a condenser was fixed. The condenser was connected to the tap water by means of a rubber tubing and the outlet of the condenser was left in the tap water basin. The whole assembly was placed on the heating mantle and extraction started using petroleum ether as the first solvent. The petroleum ether was poured from the top over the drug in the extractor till the solvent siphoned. The siphoned extract was brownish red in colour. Further more of the petroleum ether was poured so as to cover  $\frac{1}{4}$  of the volume of the drug in the extractor. The heating mantle was put on and when the solvent started boiling, the temperature was brought down and regulated, so that the constant boiling of the solvent was continued. Extraction was carried out till the siphoned extract was almost colourless. It took about 30 hours to complete the extraction and consumed 4 x 3 litres of petroleum ether. The assembly was dismantled and extract from the flask was concentrated in vacuo and marked as concentrated extract of petroleum ether. This extract was tested for presence of flavonoids and sterols. The flavonoids were tested by Shinoda's test. It failed to show presence of flavonoids in this extract. The extract was further tested for sterols by means of Liebermann-Burchard's test, which showed positive test for sterols. Therefore, the concentrated petroleum ether extract was dried on water bath to a residue for the separation of sterols.

Next the marc was taken out from the extractor and dried in air. It was further dried in a oven  $55^{\circ}\text{C}$ . This powder was repacked in another fresh thimble and placed back in the extractor. This time, chloroform was poured in and the extraction was continued till siphoned liquid did not show colour to the extract. It required 4 x 3 litres of chloroform and 16 hours for complete extraction. This extract was concentrated and tested for presence of flavonoids and sterols. It showed absence of both substances. Therefore this extract was rejected.

The marc was again taken out, dried and repacked in extractor and extracted using methanol as solvent. Extraction continued till the colour disappeared and it took 36 hours and utilised 6 x 3 litres of methanol. This methanolic extract was concentrated in vacuo and concentrated extract was tested for presence of sterols and flavonoids. It showed absence of sterols but presence of flavonoids by the above test. Therefore, this methanolic extract was digested with distilled water for 2 to 3 hours in 250 ml water on hot water bath. It was filtered. This was repeated three times and finally all the filterates were collected together. This aqueous liquid was then concentrated to a small volume and further extracted with various organic solvents ranging from ether to ethyl acetate to ethyl acetate : methanol mixture and finally with n-butanol, with the help of separating funnel till the organic phase did not show any colour to it. The aqueous extract was first extracted with solvent ether. About 1.5 litres of ether was required. Next the aqueous liquid was extracted with ethyl acetate till completion of the extraction, it required 3 litres of ethyl acetate. It was further extracted with ethyl acetate : methanol mixture in the proportion of 95 : 5. It required 1.5 litres of this mixture. Finally, the aqueous extract was extracted with n-butanol. It required 1 litre.

All these fractionated extracts from aqueous extract were concentrated

and tested for presence of sterols and flavonoids. It was found that ether extract gave red colour with Shinoda's test, brownish green colour with ferric chloride but negative test with Molisch's reagent. It showed presence of flavonoid aglycones and absence of sterols.

Ethyl acetate and mixture of ethyl acetate : methanol extracts both showed positive test for flavonoid glycosides when tested with Shinoda's test and Molisch's test. Butanol and aqueous extracts failed to show the presence of sterol & flavonoid by chemical test. Therefore, ether extract was used to isolate flavonoid aglycones and ethyl acetate mixture extract was used to isolate flavonoid glycosides.

#### Examination of petroleum ether extract

The petroleum ether extract 28 g. was refluxed with 10% alcoholic potash 300 ml. for 4 hours. The alcohol was removed by distillation in vacuo frequently making up the volume with the water. The unsaponifiable matter was extracted with ether (8 x 300 ml.) and dried over anhydrous sodium sulphate. It was filtered and ether was removed by distillation and the semisolid obtained (8 g.) was dissolved in chloroform and absorbed on neutral aluminium oxide 50 g. This was poured into an alumina column prepared as below. Petroleum ether (60-80) was poured into a glass column (4 x 70 cm) plugged with cotton at the bottom. 300 g. of alumina was carefully added and the column was allowed to run for a few minutes to remove air bubbles. This was little tapped to give uniform formation of column. About 3 - 4 cm. of layer of solvent was allowed to remain on the top. The substance to be chromatographed was poured over the column without disturbing the upper layer and the elution was started with n-hexane and continued with 5%, 10%, 20% and 50% benzene in n-hexane and then benzene alone, followed by the graded mixtures of benzene & chloroform in the above order. About 400 ml. of each mixture was used for elution and 50 ml. of eluate was collected each time. Elution with chloroform was

continued upto 700 ml. The eluates upto 20% benzene in chloroform gave only uncrystallised waxy residues, while 50% benzene in chloroform and pure chloroform eluates on concentration showed a trailing spot on TLC of silica gel G when run in a solvent of chloroform : acetone (4 : 1). These eluates were concentrated to 15 ml. The detection of the spot done by spraying with 50% sulphuric acid followed by heating the plates at 120 - 140°. Further purification of the compound was done by means of preparative thin layer chromatography (TLC), using silver nitrate coated TLC plates. 13 g. of silver nitrate was dissolved in 60 ml. of water and 30 g. of silica gel G was admixed. The plates were coated and dried in dark for 2 hours and then activated for 1 hour 110°C. In this manner, 70 plates were prepared. The solution from above containing the sterols was streaked on the plates. (0.25 ml. was streaked on each plate.) These plates were developed in a developing solvent chloroform : ether : acetic acid (97 : 2.3 : 0.5). After development, the chromoplates were dried in air. Small lengthwise portion of each plate was sprayed with 0.2% alcoholic solution of dibromofluorescein, by covering the rest of the area of the plate with a glass plate. The plate was then viewed under UV radiation of 365 nm and the two fluorescent bands were detected and marked. The corresponding bands from the rest of the plates were then scrapped of and placed in two different beakers. Each band powder was then eluted with benzene by heating on hot water bath. The eluates were then filtered and the clean filterates were evaporated to dryness. The residues so obtained from two bands were then recrystallised from methanol. The lower band of Rf value 0.86 corresponded to compound B and the upper band of Rf value 0.90 corresponded to compound A. The yield of compound A was 640 mg. and that of compound B was 110 mg. The melting points of compound A was 142° - 144° and while that of the compound B was 160° - 161°. The confirmation of the structures of these two compounds was done by spectral data analysis and preparation of derivatives.

Compound A:

Compound A :- Melting point  $142^{\circ} - 142^{\circ}$ . It gave red colour in Salkowski's test and a green colour in Liebermann Burchard's test. It gave a yellow colour with tetranitromethane. It was soluble in benzene and chloroform. Molecular wt from Mass is 414.

Elemental analysis: Compound A was found to have C = 83.5%, H = 12.44% & O = 4.06% against the requirement of C = 83.99%, H = 12.15% and O = 3.86%.

UV :  $\lambda_{\text{Max}}$  MeOH nm 205.2. The results are shown in figure 1.

IR Bands  $\nu_{\text{Max}}$  KBr  $\text{cm}^{-1}$  3400  $\text{cm}^{-1}$  (-OH) bending vibration, 3030, 1660  
 OG = C (stretching vibration of  $\beta$  - Sitosterol.)

IR is superimposable with Aldrich catalogue No.1494 A. The results are shown in figure 2.

Mass Spectroscopy: It gave major peaks at  $m/z$  414 ( $M^+$ ), 399 ( $M-Me$ )<sup>+</sup>, 396 ( $M-H_2O$ )<sup>+</sup>, 381 ( $M-Me-H_2O$ )<sup>+</sup>, 329 ( $M-85$ )<sup>+</sup>, 303 ( $M-C_7H_{11}O$ )<sup>+</sup>, 273 ( $M-Sc-H_2O$ )<sup>+</sup>, 231 ( $M-Sc-C_3H_6$ )<sup>+</sup>, 213 ( $M-Sc-C_3H_6-H_2O$ )<sup>+</sup>. This fragmentation agrees with the literature values reported for  $\beta$ -sitosterol. The results are shown in figure 3.

Acetylation of Compound A: Compound A (50 mg.) was taken up in dry Pyridine (0.5ml) & freshly distilled acetic anhydride (3 ml.) was added to it. The mixture was refluxed for 3 hours. The mixture was kept at room temperature, overnight and then added to ice water and finally stirred. The solid obtained was filtered, dried and was crystallised from benzene as fine needles, m.p.  $126^{\circ} - 128^{\circ}$ .

Benzoylation of Compound A: Compound A (50 mg.) was taken up in a dry pyridine (1.5 ml.) and benzoyl chloride was added to it. It was shaken well and left overnight. Then the mixture was poured on ice and the colourless solid formed was filtered, dried and crystallised from ethanol as shining needles m.p.  $139^{\circ} - 140^{\circ}$ .

From the above analytical studies, the compound A was found to be

PERKIN-ELMER LAMBDA 15 UV/VIS SPECTROPHOTOMETER

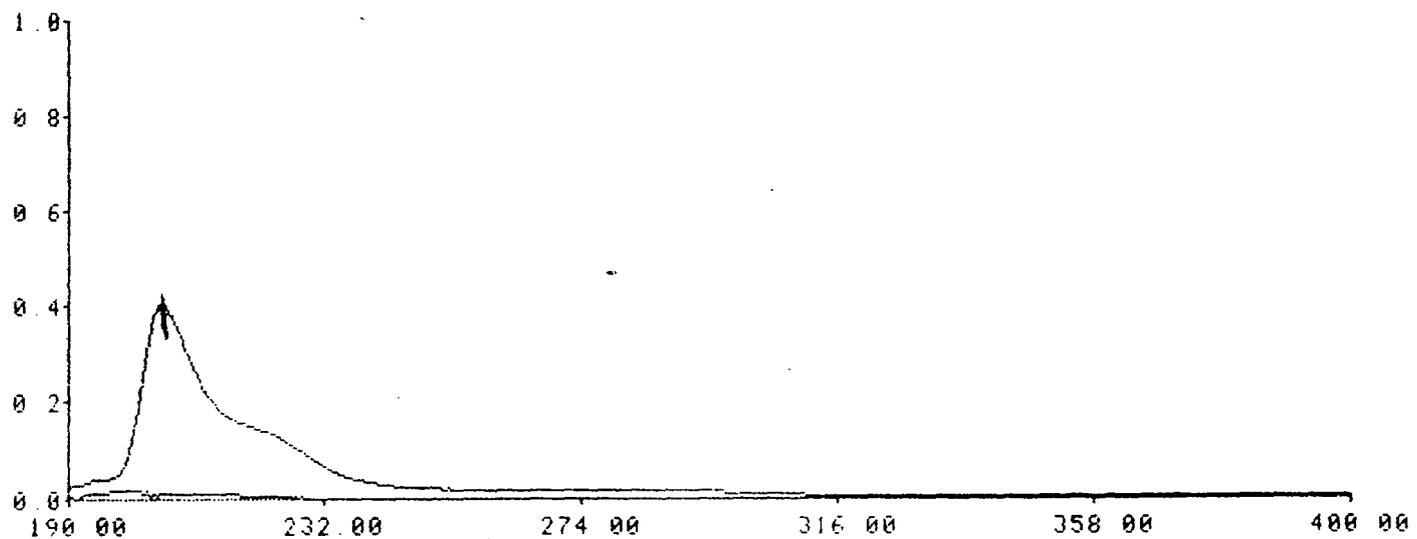


Figure 1

PERKIN-ELMER  
LAMBDA 15 UV/VIS SPECTROPHOTOMETER  
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METHOD SCAN: MANUAL

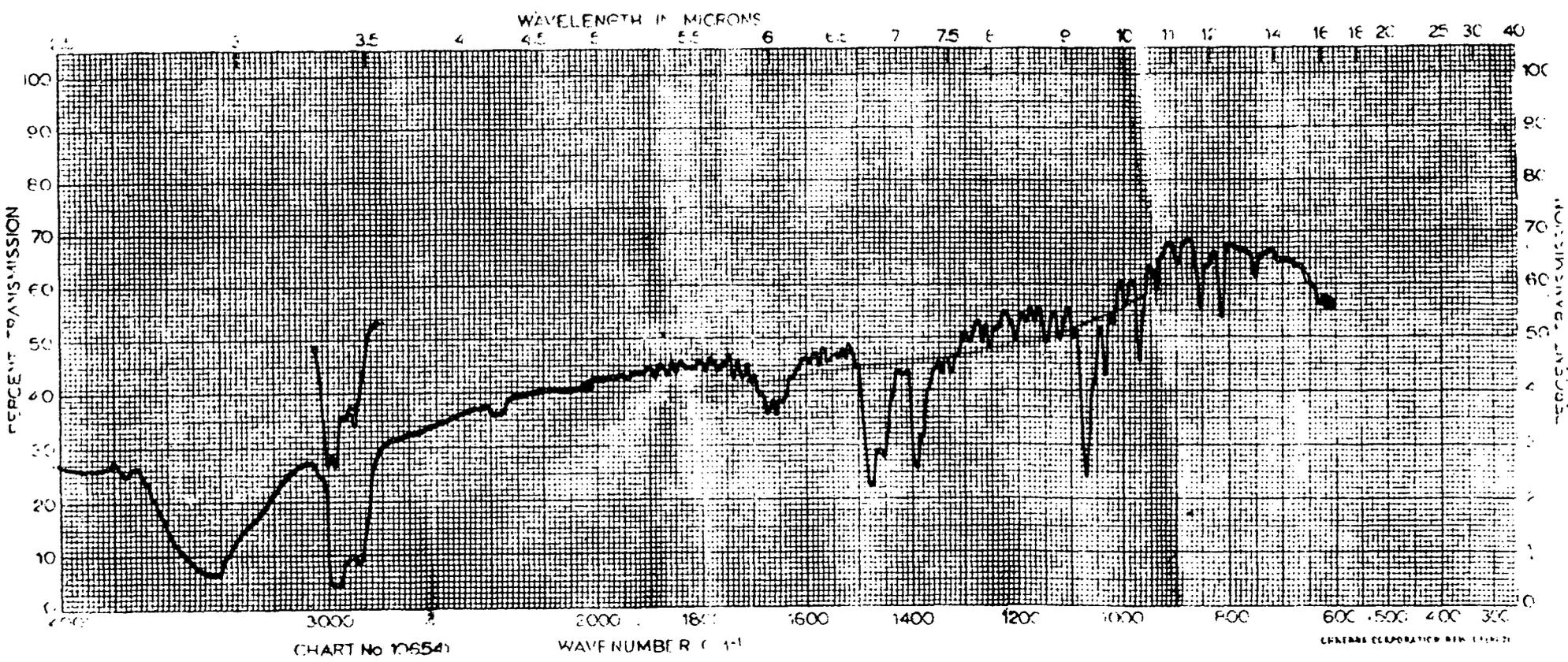


Figure 2

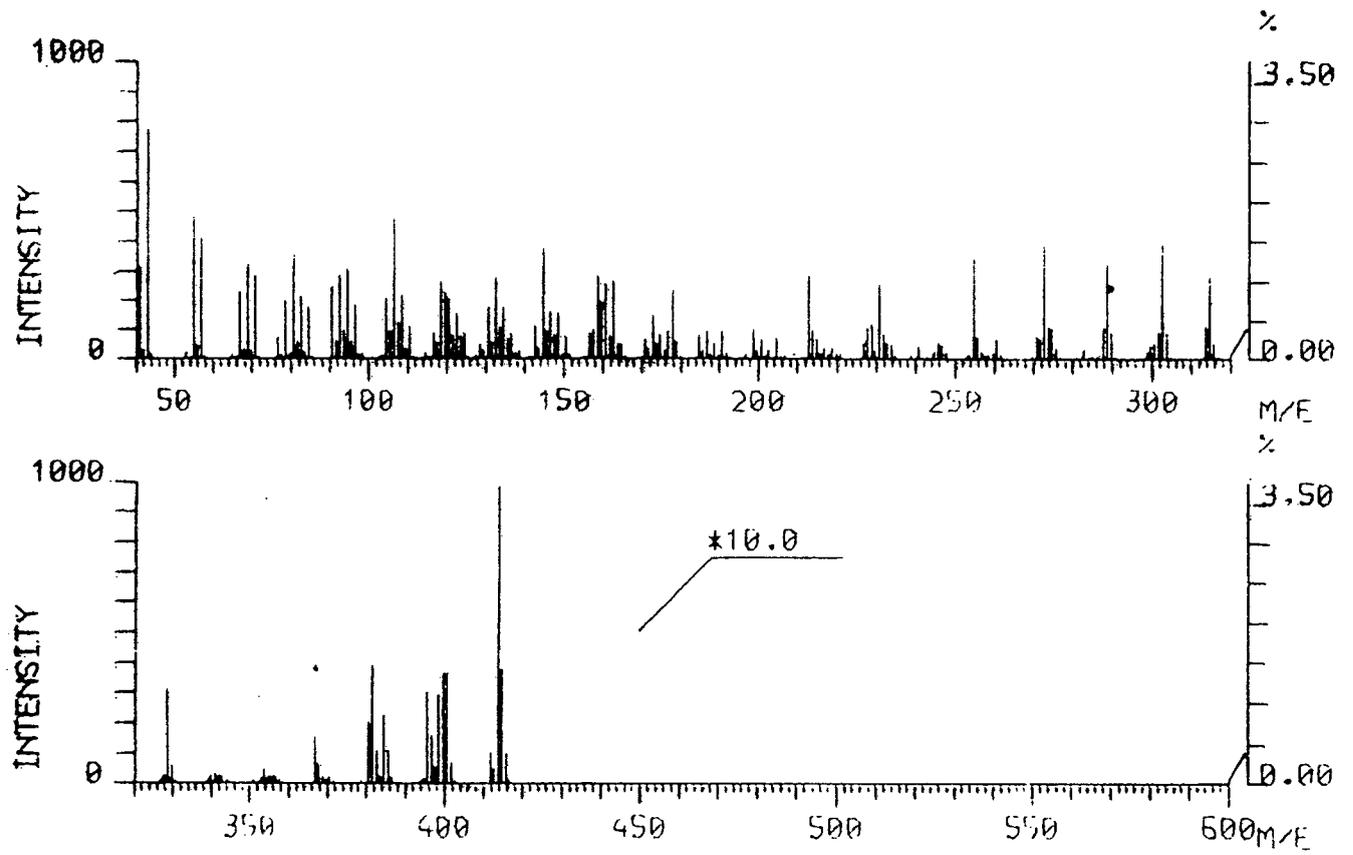


Figure 3.

$\beta$  - sitosterol.

Compound B:

Compound B :- Melting point  $160^{\circ}$  -  $161^{\circ}$ . It gave a red colour in Salkowski's test and a green colour in Liebermann Burchard's test. It gave a yellow colour with tetranitromethane. It was soluble in benzene, chloroform and petroleum ether.

Molecular weight from Mass is 412.

Elemental analysis: Compound B was found to have C = 83.28%, H = 11.11% & O = 5.61% against the requirement of C = 84.40%, H = 11.72% & O = 3.88%.

UV:  $\lambda_{\text{MeOH}}^{\text{Max}}$  nm 210.8      The results are shown in figure 4.

IR Bands  $\nu_{\text{KBr}}^{\text{Max}}$   $\text{cm}^{-1}$  3430  $\text{cm}^{-1}$  (-OH), 1640 (double band)

The results are shown in figure 5.

IR is superimposable with Aldrich catalogue No.1494B of stigmasterol.

NMR Signals: ( $\text{CDCl}_3$ , 90 MHz)  $\delta$  at 0.0.668 (S H - 18) 0.98 (S, H - 19), 1.022 (H - 21, d), 0.7 (H - 26), 0.78 (H - 29), 0.82 (H - 26), 3.45 (br, m, H - 3), 5.3 (H - 6), 5.1 (H - 22 or H - 23). The results shown in figure 6.

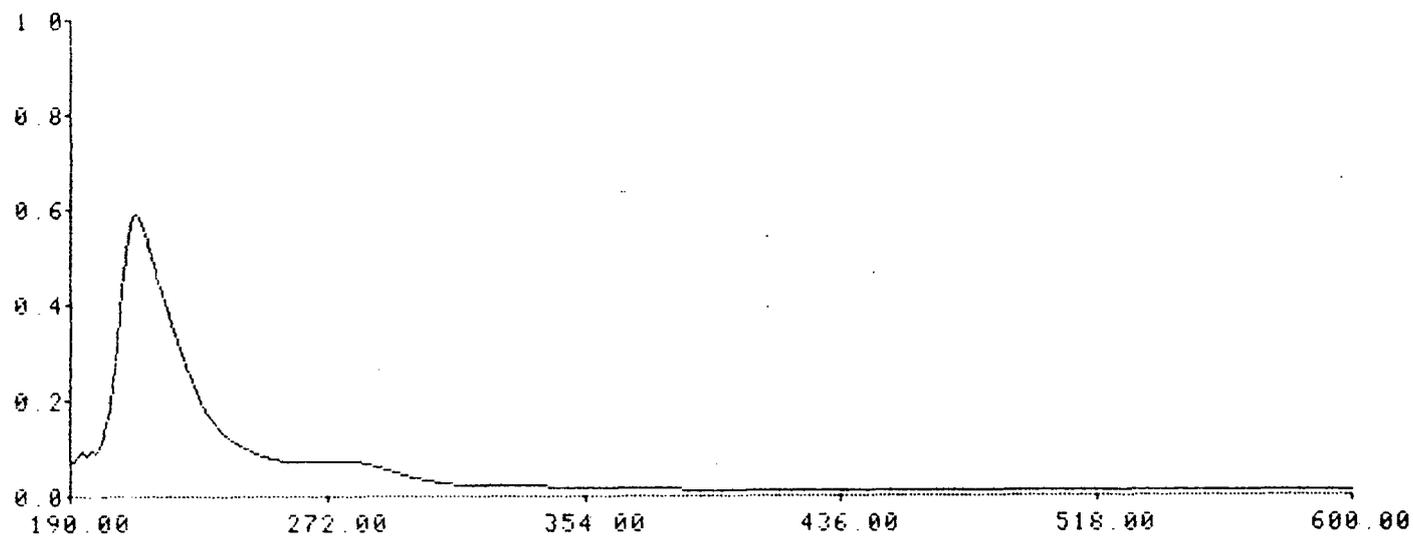
Mass Spectroscopy: Peakes at  $m/z$  412 ( $M^+$ ), 394 ( $M-H_2O$ ), 369 ( $M-C_3H_7$ )<sup>+</sup>, 314 ( $M-98$ )<sup>+</sup>, 300 ( $M-C_7H_{12}O$ )<sup>+</sup>, 299 ( $M-113$ )<sup>+</sup>, 273 ( $M-Sc$ )<sup>+</sup>, 272 ( $M-Sc-H$ )<sup>+</sup>, 255 ( $M-Sc-H_2O$ )<sup>+</sup>, 231 ( $M-Sc-C_3H_6$ )<sup>+</sup>, 229 ( $M-Sc-C_3H_8$ )<sup>+</sup>, 213 ( $M-Sc-C_3H_6-H_2O$ )<sup>+</sup>, 211 ( $M-Sc-C_3H_8-H_2O$ )<sup>+</sup>.

This fragmentation pattern is in agreement with that described in literature for stigmasterol. The results are shown in figure 7.

Acetylation of Compound B: Compound B (30 mg.) was added to freshly distilled acetic anhydride (3 ml.) and fused sodium acetate (1 g.) and pyridine (1 ml.). The mixture was refluxed for 3 hours and then poured in ice cold mixture. The crude solid obtained was filtered, dried and crystallised from methanol as colourless crystals m.p.  $143^{\circ}$  -  $144^{\circ}$ .

From the above analytical studies, the compound B was found to be stigmasterol.

PERKIN-ELMER LAMBDA 15 UV/VIS SPECTROPHOTOMETER



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METHOD

Figure 4.

SCAN/MANUAL

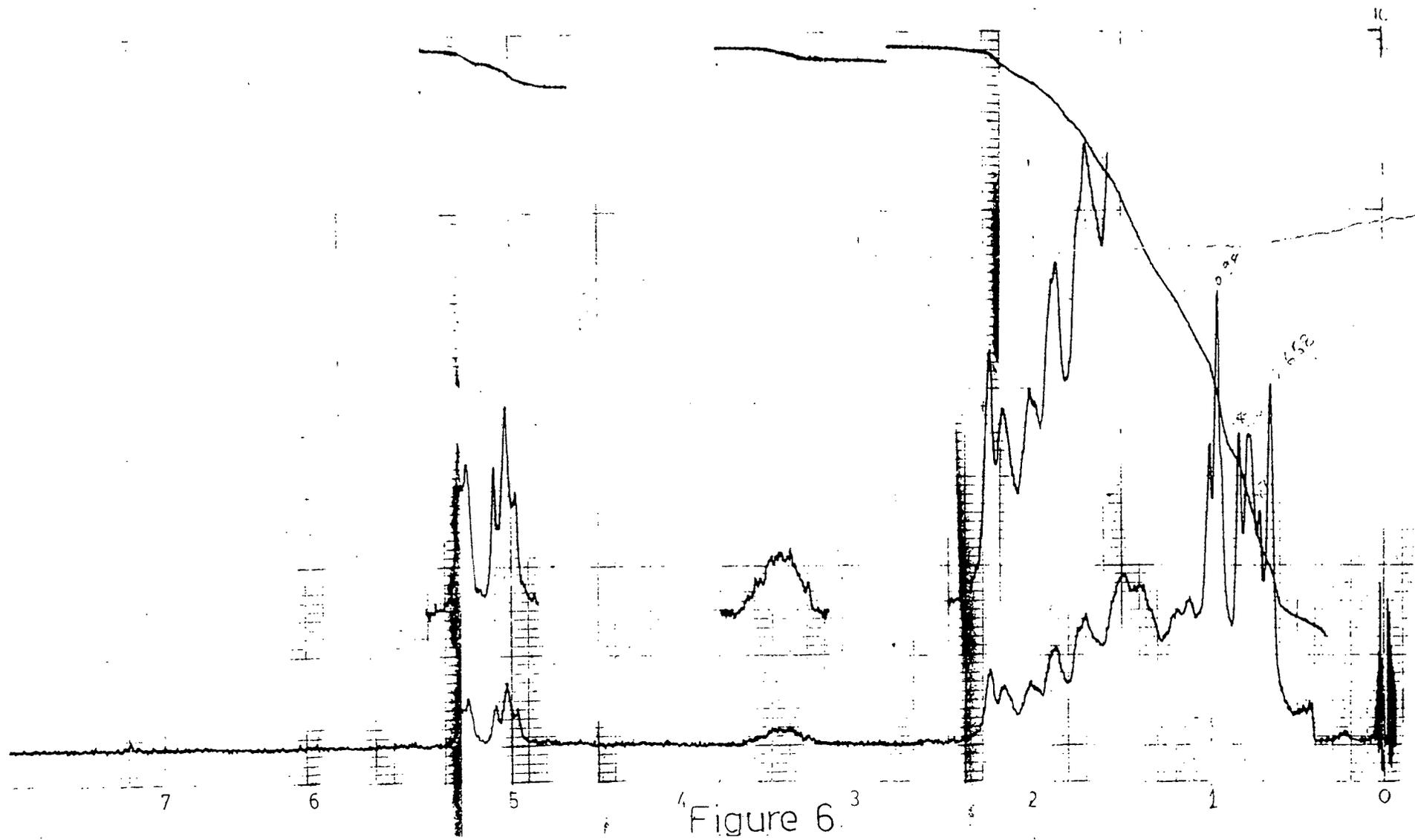


Figure 6.

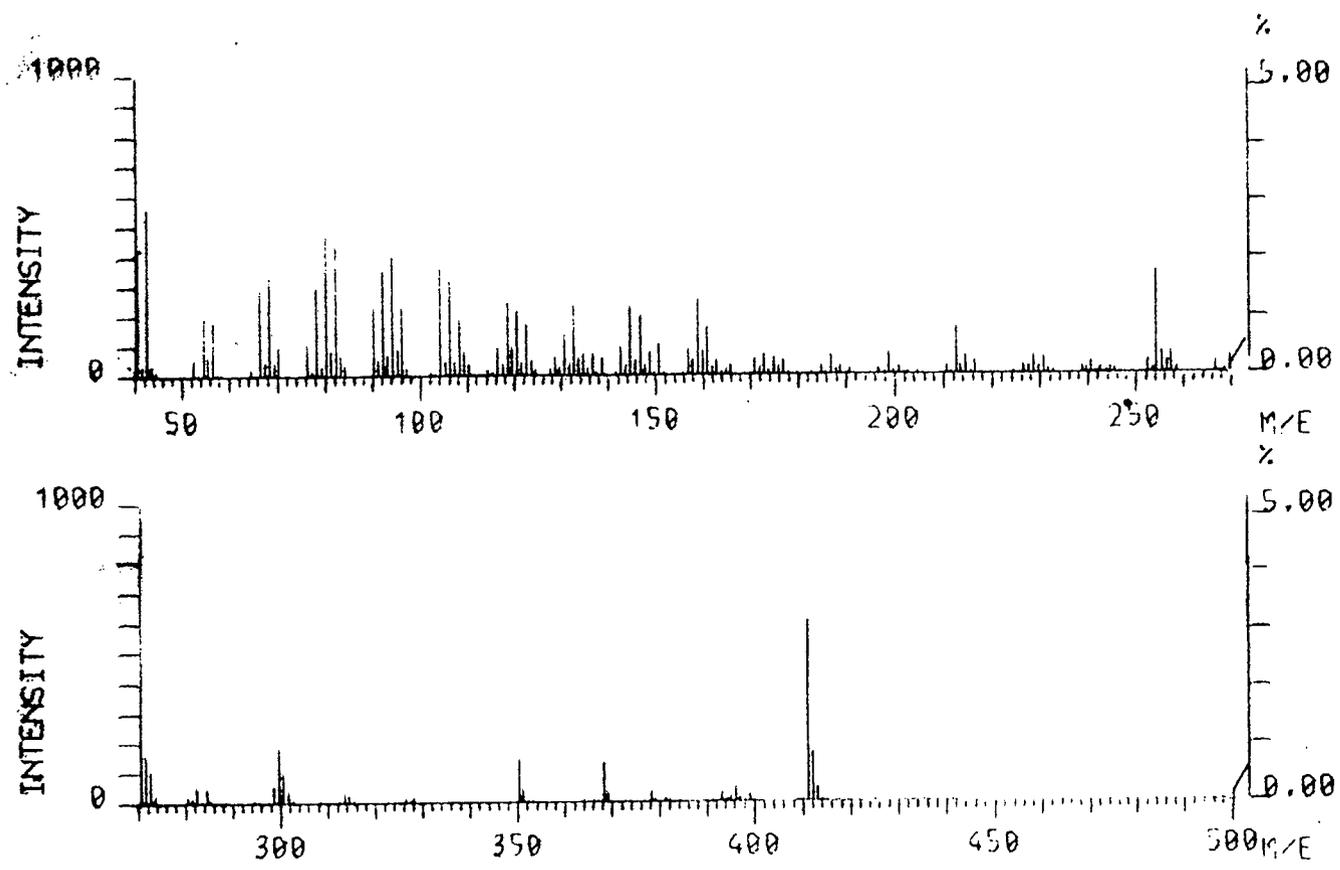


Figure 7

Examination of ether extract:

The ether extract was concentrated in vacuo. The residue (3.4 g.) was transferred to a 100 ml. conical flask using 50 ml. of methanol. The methanolic solution was concentrated to 20 ml. and kept in refrigerator. Light yellow green crystals which separated after 3 days were filtered off, washed with little ice cold methanol and dried, (240 mg.). Thin layer chromatography (silica gel G on developing solvent, ethyl acetate : formic acid : water in proportion of 8:1:1) of this substance revealed presence of flavonoid alongwith other colouring matter when tested with aluminium chloride reagent. Therefore, separation of this flavonoid in the mixture was achieved by dissolving the substance in minimum quantity of methanol and subjected to silica gel column chromatography. A fine suspension of silica gel (column chromatographic grade) in ethyl acetate was prepared by stirring silica gel (200 g.) with ethyl acetate (400 ml.). This uniform slurry was added as a continuous stream to a glass column of 4 x 70 cm. size plugged at the bottom with cotton, till a height of 30 cm. silica gel was obtained. The solvent was allowed to run at the rate of 15 - 20 drops per minute. The ether residue (240 mg.) in methanol was poured over the column and eluted with ethyl acetate 300 ml. and then with gradient mixtures of ethyl acetate and methanol in proportion of 5%, 10%, 20%, 30% and 50% methanol and finally pure methanol. 300 ml. of each mixture was used and each time 50 ml. of eluate was collected and tested for presence of flavonoid. It was found that only 20% above mixtures of methanol in ethyl acetate gave similar spot when tested for TLC. Therefore, these eluates were collected together, concentrated and residue so obtained was recrystallised from methanol. Yellowish green crystals, decomposing at 347°C in the yield of 65mg. were obtained. This compound was designated as compound C and subjected to colour test. When tested with Shinoda's test, it gave red colour and with ferric chloride reagent it gave brownish green colour. It was subjected to elemental analysis, UV IR and Mass spectroscopy. Due to paucity of the sample, it was not possible to have NMR spectra.

205  
Compound C:

Elemental analysis : Compound C was found to have C = 53.60%, H = 3.63% & O = 42.77%.

UV :  $\left\{ \begin{array}{l} \text{MeOH} \\ \text{Max} \end{array} \right.$  nm 374.4, 252.8, 208.8, 301.2. The results are shown in figure 8.

IR Bands  $\left\{ \begin{array}{l} \text{KBr} \\ \text{Max} \end{array} \right.$   $\text{cm}^{-1}$  Hydroxyl groups at 3400, 3470, 3500 and absorption at 1655, 1620, 1560, 1510, 1490, 1460, 1440, 1360, 1330, 1280, 1240, 1225, 1200, 1170, 1120, 1090, 1040, 1025, 1000, 960, 860, 830, 800, 770, 740, 710, 670, 650. The results are shown in figure 9.

Mass Spectroscopy:  $M^+$  270, m/e 242, 213, 196, 168, 152. The results are shown in figure 10.

Since it did not match with IR of known compounds from Aldrich catalogue, based on the above data, we arrived at a tentative flavanol structure with the hydroxyl groups at 3, 6 & 8 of A ring.

Examination of ethyl acetate and ethyl acetate : methanol (95 : 5) fractions:

These two fractions were mixed together and concentrated to a thick solution of 15 ml. It was monitored on TLC (silica gel G) in developing solvent ethyl acetate : formic acid : water (8 : 1 : 1) and sprayed with boric acid reagent to detect the flavonoids. It showed a prominent fluorescent spot along with other non-flavonoid impurities. Therefore, this solution was poured on silica gel column prepared as below. A fine suspension of silica gel (column chromatographic grade) in ethyl acetate was prepared by stirring silica gel (100 g) with dry acetone (200 ml.). This uniform slurry was added as a continuous

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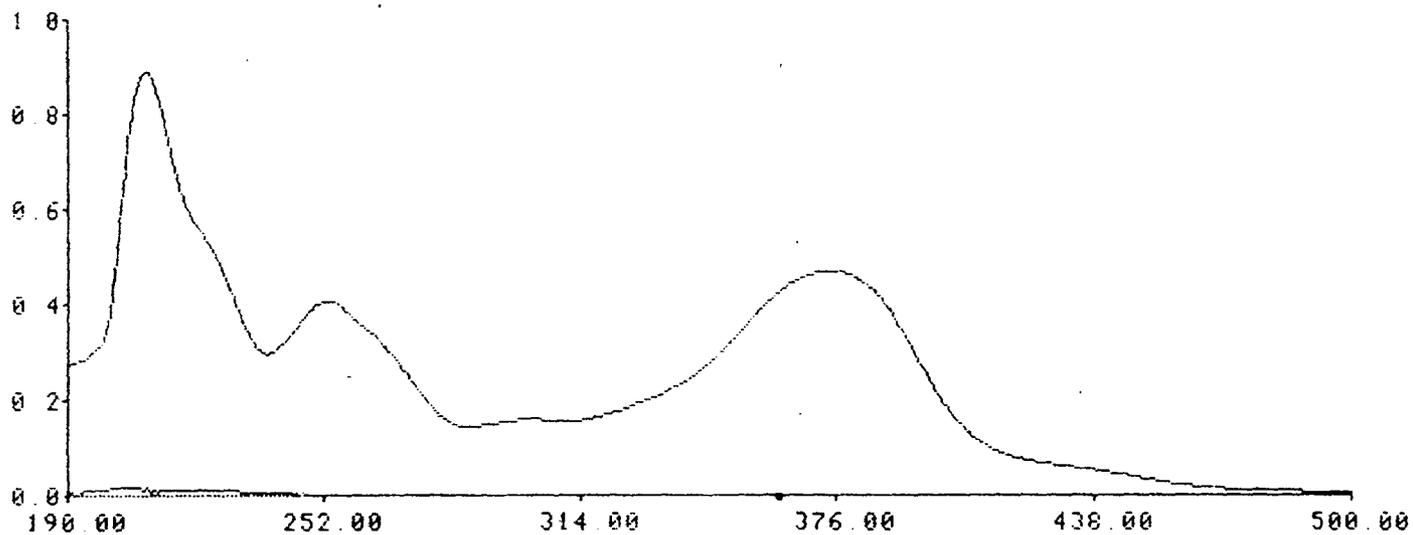


Figure 8.

PERKIN-ELMER  
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METHOD SCAN/MANUAL

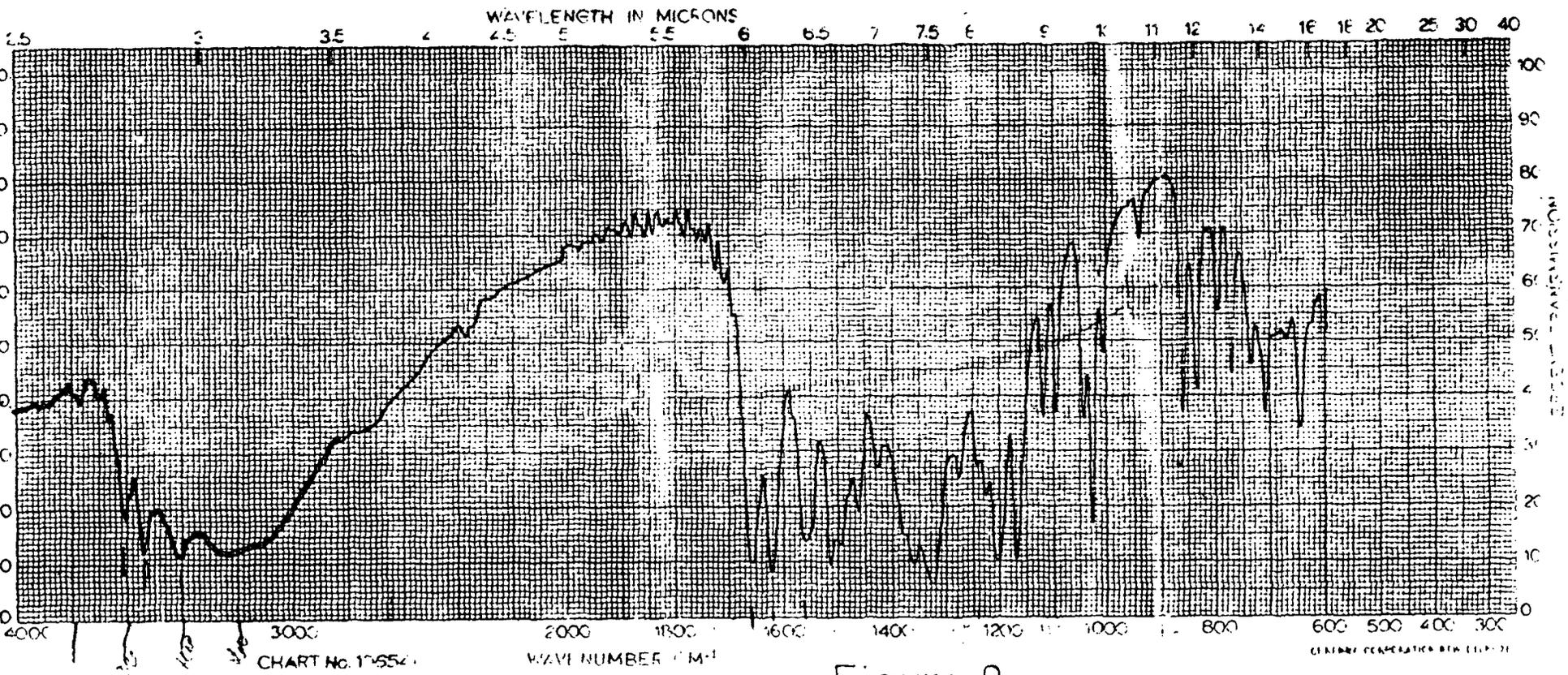


Figure 9

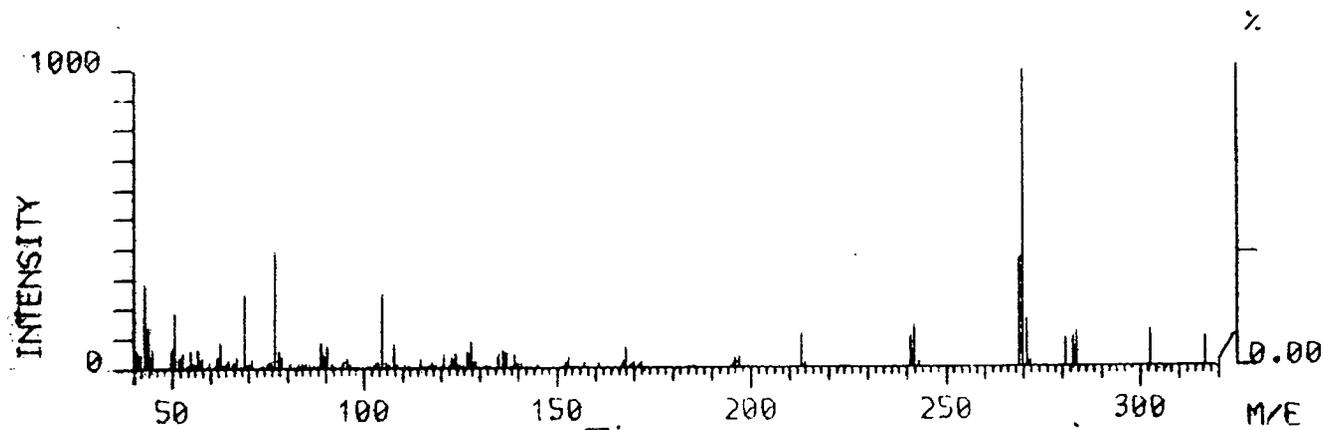


Figure 10

stream to a glass column (2 x 45 cm) plugged at the bottom with cotton, till a height of 20 cm silica gel was obtained. The concentrated ethyl acetate extract was carefully put on the top of the column when a 2 cm height of the solvent was remaining. Elution was started first with acetone and continued with 25%, 50% ethyl acetate, pure ethyl acetate and 1%, 2% and 5% methanol in ethyl acetate. The solvent was allowed to run at the rate of 15 - 20 drops per minute. The quantity of eluate collected each time was 50 ml. and the volume of each eluant used was 300 ml. The eluates upto the ethyl acetate did not show the fluorescent spot and therefore discarded. Eluates from 1% methanol and above showed the fluorescent spot along with two other non-flavonoid spots when monitored on TLC as above. 1% methanol in ethyl acetate and above eluates on concentration gave a yellow solid (720 mg.) which was shown to consists of some impurities. Therefore, further purification of the compound was done by dissolving it in 15 ml. ethyl acetate : methanol (95 : 5) mixture and separating the compound by preparative thin layer chromatography using silica gel G as adsorbent and boric acid spray for detection. 70 plates were prepared of 500  $\mu$  thickness and the solution was streaked on the plate as in the earlier case. A small edge of the plate was utilised for boric acid spray for detection and location of the spot. The fluorescent spot occurred at Rf value 0.45 free from other impurities was scrapped out from the plates and extracted from methanol. The methanolic solution was concentrated when a yellow crystalline solid of m.p. 185° - 190° in the yield of 470 mg. was obtained which was designated as compound D.

Compound D:

Compound D was found to have C = 47.65%, H = 5.06% & O = 47.29% against the requirement of C = 53.11, H = 4.95% & O = 41.94% Molecular weight from FIMS was reported to be 610.

UV :  nm 375.2, 268.0, 213.2 . The results are shown in figure 11.

IR Bands (  $\nu$  )  $\left. \begin{array}{l} \text{KBr} \\ \text{Max} \end{array} \right\} \text{ cm}^{-1}$  . It showed broad OH at  $3400 \text{ cm}^{-1}$  and absorption peaks at 1670, 1620, 1570, 1560, 1510, 1470, 1370, 1300 and it is superimposable with Aldrich catalogue No.906 H of rutin. The results are shown in figure 12.

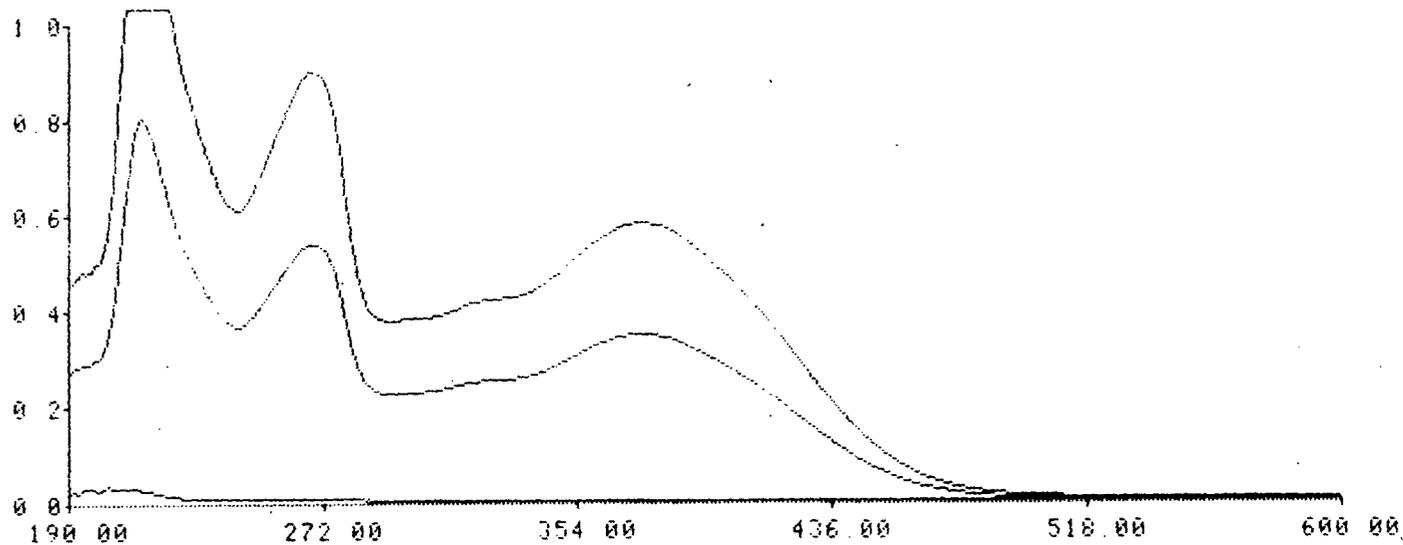
Mass Spectroscopy: FDMS showed  $632 (M + Na)^+$ ,  $610 M^+$ ,  $464 (M - 146)^+$ ,  $m/z$  302.

Hydrolysis of Compound D: 20 mg. of compound D was dissolved in 20 ml. of methanol and transferred to a 100 ml. of conical flask containing 40 ml. of 5% hydrochloric acid. The reaction mixture was refluxed for 8 hours, and then tested chromatographically for complete hydrolysis. The reaction mixture was stored in a refrigerator overnight whereby a part of the aglycone precipitated out. This precipitate was separated by filtration and the remaining aglycone in the filtrate was removed by extraction with ether. The aqueous phase of the hydrolytic solution was preserved for identification of sugars. The ether extract was evaporated on a watch glass to give a residue corresponding to aglycone. This was mixed with the precipitate earlier obtained. This aglycone was recrystallised from methanol to yield yellow crystals marked as compound E.

Compound E :

Compound E :- M.P.  $312 - 316^{\circ}$  gave a bluish crimson colour with Shinoda's test and olive green colour with alcoholic ferric chloride. It was yellow under UV, becoming bright yellow with ammonia UV.

Elemental analysis : Compound E was found to have C = 51.32, H = 4.17 & O = 44.51% against the requirement of C = 59.61%, H = 3.34% & O = 37.05%.



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METHOD

SCAN/MANUAL

Figure 11

UV :  $\lambda$  <sup>MeOH</sup> nm 382.8, 269.2, 212.8 . The results are given in figure 13.  
 Max

IR Bands:  $\nu$  <sup>KBr</sup> )  $\text{cm}^{-1}$  It showed broad OH at  $3400 \text{ cm}^{-1}$ , 1680, 1620  
 Max is superimposable with Aldrich catalogue  
 No.906F of quercetin. The result are shown  
 in figure 14.

Mass Spectroscopy: m/z  $302 \text{ M}^+$ , 286, 270, 254, 245, 229, 212, 198, 152, 150. The results are shown in figure 15.

Acetylation of Compound E: Compound E (50 mg) was dissolved in freshly distilled acetic anhydride (3 ml.) and 2 drops of pyridine was added to it. The mixture was refluxed for two hours and left overnight at room temperature. The product was crystallised from ethanol to yield colourless needles m.p.  $198^{\circ} - 200^{\circ}$ .

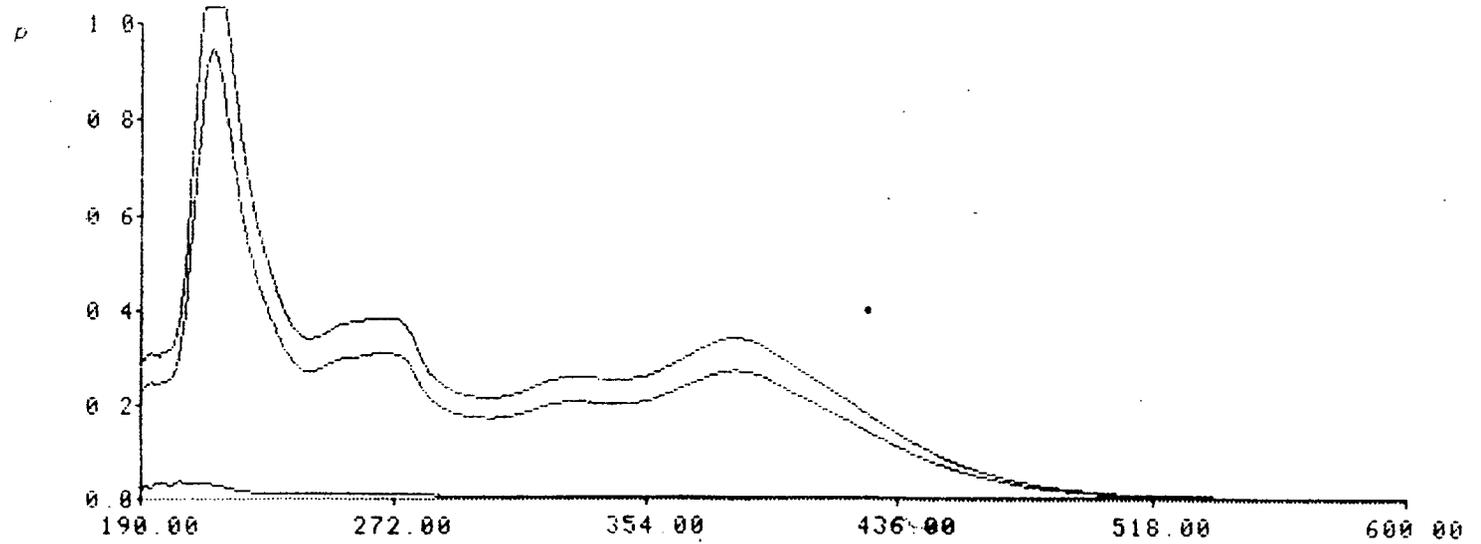
Complete methylation of Compound E: Compound E (50 mg.) was refluxed with freshly distilled dimethyl sulphate (2 ml.) and anhydrous potassium carbonate (5 g.) in dry acetone for 48 hours and then the mixture was poured into ice water. The precipitate was collected, washed with water and dried. It was recrystallised from methanol to yield colourless needles m.p.  $152^{\circ} - 153^{\circ}$ .

From the above analytical studies, the compound E was found to be Quercetin.

Examination of aqueous phase of hydrolytic solution of Compound D:

This aqueous phase was utilised for identification of the sugars. The aqueous hydrolytic solution free of aglycone was acidic and therefore was neutralised by ion exchange resin (Dowex - 2). Sufficient quantity of resin was taken

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METHOD

SCAN/MANUAL

Figure 13

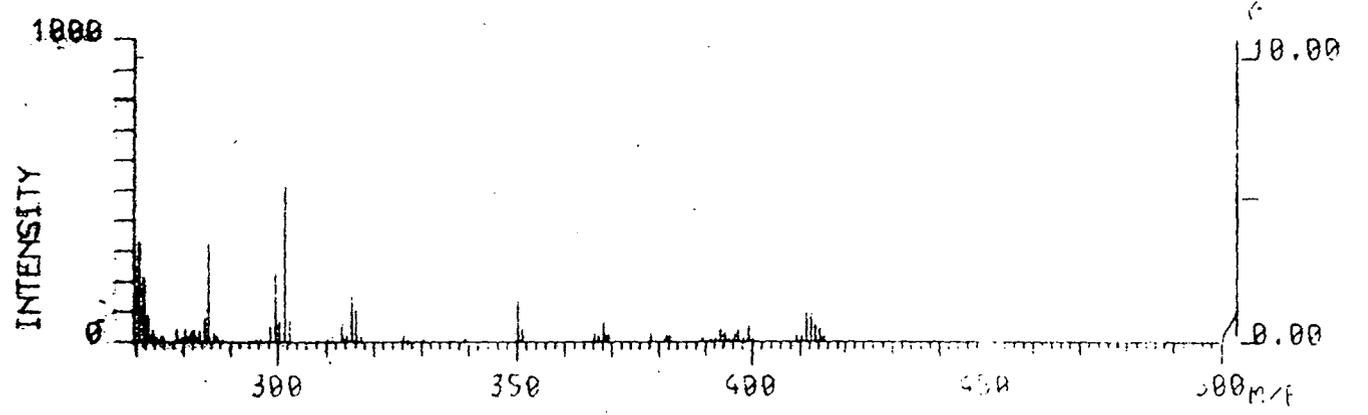
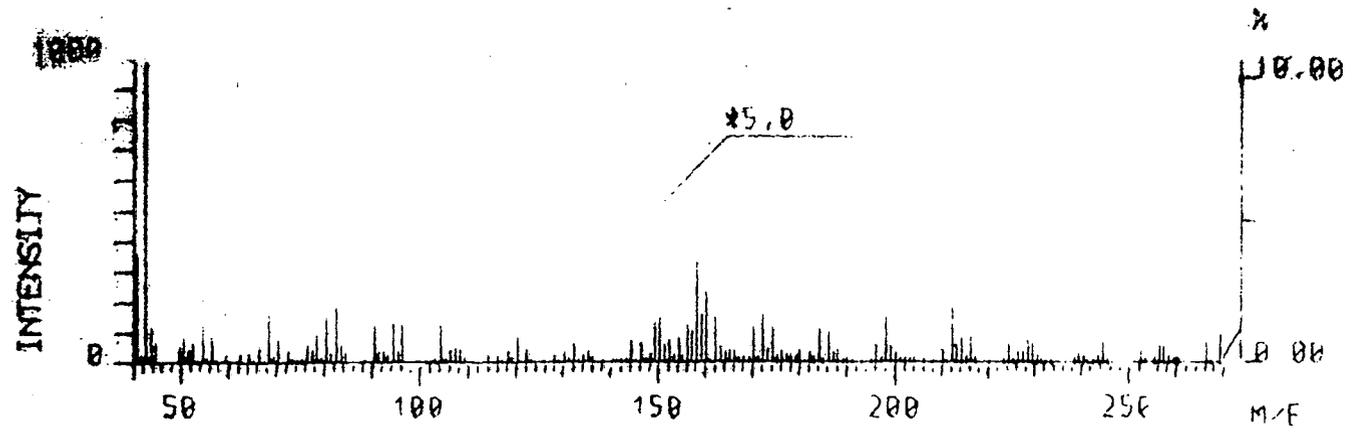


Figure 15

in a 250 ml. beaker. 100 ml. of 4% of sodium hydroxide was added and the mixture was kept stirring with a mechanical stirrer for 40 minutes. The resin was filtered through muslin and washed several times with distilled water till the washings were neutral to red litmus. 100 ml. of 4% hydrochloric acid was added to the resin and again stirred for 40 minutes, filtered and muslin was washed till the washings were neutral to blue litmus. The resin was then ready for use.

This regenerated ion exchange resin was added to the acidic hydrolytic solution (containing sugars) in portions with continuous stirring till the neutralisation was complete as tested with litmus. The resin was filtered off on a filter paper using a buchner funnel and washed with hot water 2 to 3 times to remove the adhering sugars completely. The aqueous filtrates were combined and concentrated in chinadish over a hot water bath. The residue obtained was dissolved in 1 ml. of pyridine and spotted on a chromatographic paper (whatman No.1) alongwith solutions of known sugars rhamnose & glucose. 5  $\mu$ l of a 5% sugar solution was applied. The chromatogram was developed for 16 hours (overnight) with butanol : pyridine: water (7:4:3) as solvent system. The developed chromatogram was allowed to <sup>ow</sup>dry in air and then sprayed <sup>with</sup> aniline pthalate reagent. After heating the chromatogram in oven at 110°C for 10 minutes, the unknown sugars were identified by direct comparison of its Rf values with those of known sugars. Two spots were seen, one a dark brown spot corresponding to D-Glucose Rf value 0.43 and other as pink spot corresponding to L-Rhamnose Rf value 0.70. Thus the sugar were identified as D-glucose and L-rhamnose. Thus from the analytical studies, Compound D was identified as Rutin.

CHAPTER VIII  
DISCUSSION AND CONCLUSION



CHAPTER VIIIDISCUSSION & CONCLUSION

Goa situated on the Western ghat of the Central West coast of India is well known for its tropical rain forest with mountainous range and heavy rainfall. The plant wealth of this area has become very interesting, particularly for the medicinal uses by the local people of Goa. The pharmacognostical or phytochemical aspects of the plants from the Goa region have not been reported so far, may be because Goa for the last more than 450 years was under Portuguese regime, cut-off from the rest of India. Garcia da Orta (1563), Acosta (1578), Silva (1862), Dalgado (1898), Souza (1944), Vartak (1966) and Rao (1985, 1986) are some of the research workers who have reported about the plants from Goa region, whose reference have been cited in this thesis.

On the basis of the literature survey and personal visits, discussions, to many people, it has been observed that there has been a very strong, old tradition to use herbal medicine for various ailments. Although, there is lot of information available, it was felt that most of this knowledge is restricted to the local people who don't want to part with this and hence have imposed some social taboo.

With this background, efforts have been made to investigate into the pharmacognostical aspects of these local plant products. The vegetation of Goa composed of dry deciduous species such as, Holarrhena antidysenterica, Grewia microcos, Lantana camara & Vitex negundo. The prominent tree species found along the foot hill slope of hilly tract are Pterocarpus marsupium, Sterculia urens, Cocculus macrocarpus, Helecteres isora, Hydnocarpus wightiana, Careya arborea, Glycosmis pentaphylla, Rauwolfia serpentina, Smilax macrophylla, Caesalpineae

crista, Zizyphus rugosa, Casearia esculenta & Stephania hernandifolia. The plants which are especially grown in Morlem forest of Sattari taluka and usually not found in other forests of Goa are Maesa indica, Machilus macrantha, Polyalthia fragrans, Casearia esculenta, Citrus medica & Paederia foetida because of high altitudes of hilly region. Some plants selected for study were of cultivated variety like Momordica dioica, Murraya koenigii, Mimusops kauki, Oldenlandia corymbosa, Averrhoa bilimbi, Annona squamosa, Cymbopogon citratus and Kaempferia rotunda. These plants have been investigated pharmacologically for various uses. To quote a few examples, Dhawan et al (1980) claimed that aqueous extract of Momordica dioica tuber is having spermicidal activity & anthelmintic activity. Ethanolic extract of Murraya koenigii whole plant excluding roots, showed anti-protozoal activity and antispasmodic activity on isolated guinea pig ileum as reported by Bhakuni et al (1969). Narayana & Sastry (1975) investigated that aqueous extract of Murraya koenigii leaves is having hypoglycaemic action in normal and alloxan diabetic dogs. The leaves of Murraya koenigii which are used in curry were found by Goutam & Purohit (1974) to have antibacterial effect. Chatterjee & Bhattacharyya (1955) reported  $\beta$ -sitosterol in roots of Hemidesmus indicus. Hibiscus rosa-sinensis has been investigated extensively by many workers for its antifertility effect as reported by Batta & Santhakumari (1971), Prakash & Mathur (1976) and Kholkute and Udupa (1974). The therapeutic utility of Holarrhena antidysenterica in acute & chronic amoebic dysentery has been investigated by several workers such as Chopra et al (1927, 1933), Dutta & Iyer (1968) and Basu & Jayaswal (1968). Tripathi & Tripathi (1982) reported that the leaf extract of Leucas aspera has antiviral activity against common mosaic virus, while Misra & Dixit (1979) have reported that its alcoholic leaf extract showed fungitoxic activity against Ustilago hordei. Vijayalakshmi et al (1979) reported that the leaf extract of Mimusops elengi show antibacterial activity. Considering the ample use of these indigenous drugs in medicine, these drugs were studied for their pharmacognostic survey. The taxonomical characters of these plants

have been reported by Hooker (1872-97), Cooke (1901-1908) and others. It has been observed that some vernacular names given for the drugs by Vartak (1966) and Rao (1985, 1986) are different than those mentioned in the present studies. To cite few examples, Annona squamosa is called locally as 'Ater' as well as 'Sitaphal'. Vartak has mentioned only 'Sitaphal'. Vartak (1966) reported Cissampelos pereira as 'Pahadvel' while this name has been used for Stephania hernandifolia which is actually known locally. Capparris zeylanica is reported as 'Taramati' while it is also called 'Katya-Ghosvel'. Vartak further mentioned name 'Atki' for Maesa indica while it was observed that Maesa indica is called as 'Vavling'. Vartak has not given vernacular name for Lygodium flexuosom, Arundinella gigantea, Gymbopogon citratus, while such names have been mentioned in the present study. Vartak has mentioned Asparagus racemosus as 'Sasarmuli' when it is locally called as 'Sosro'. Hydnocarpus wightiana is represented by name 'Kavamthi' (Rao, 1986) while present investigations found its name as 'Kastel'. Further, Helicteres isora is named as 'Kiran' (Rao, 1986) but the present studies reported it as 'Tupkevan' or 'Altay'. Similarly, Canjeera rheedii is named as 'Tilo caro' by Rao (1986) while it is called as 'Deplus' in the present studies.

Since the medicinal activity lies in the correct part of the plant and moreover the drugs are sold in powder form, therefore the microscopical characters were studied to establish the standards for these drugs. These observations revealed good comparison between different drugs. Roots of Pterocarpus marsupium and Caesalpinea crista belonging to the family of Leguminosae were differentiated based on absence of fibres in C. Crista while presence of them in P. marsupium. Similarly C. crista showed abundant prisms of calcium oxalate crystals which were absent in P. marsupium. Nayar et al (1979) has reported earlier the presence of few crystal fibres, vessels, tracheids, fibre tracheids, all elements being lignified, in P. marsupium. Roots of Stephania hernandifolia, Tinospora cordifolia and Cocculus macrocarpus belonging to the same family Menispermaceae were differentiated based on fibres and calcium oxalate crystals. S. hernandifolia showed absence of fibres

and crystals, while septate type of fibres were found to be present in C. macrocarpus. In the present investigation, roots of Paederia foetida showed absence of starch grains and presence of stone cells as well as fibres. The detailed pharmacognostical studies of P. foetida were undertaken by Gupta et al (1971) and Prasad et al (1971) who reported presence of raphides of calcium oxalate crystals, starch grains and absence of stone cells. The present study revealed abundant cluster crystals of calcium oxalate in roots of P. foetida which were absent in Ixora parviflora belonging to the same family Rubiaceae. In the present study, leaves of Croton oblongifolius were differentiated from the leaves of Ricinus communis based on presence of peltate trichomes in C. oblongifolius. Leaves of Tamarindus indica showed secretory cells and that of Cassia fistula showed stellate and glandular trichomes while Mimosa pudica showed branched trichomes, all of them belonging to the same family Leguminosae. Leaves of Malvaceae family were found to contain peltate type of trichomes, a common character among them. Some trichomes of leaves of Averrhoa bilimbi were lignified. Bark of Annona squamosa were found to contain prominent needle shaped crystals which were absent in case of Polyalthea fragrans belonging to the same family Annonaceae. Careya arborea bark showed abundant brownish glands not seen in case of Eucalyptus globulus bark belonging to the same family Myrtaceae. Bark of Vitex negundo was found to have fibres and cluster crystals which were absent in Gmelina arboræa bark belonging to the family Verbenaceae. Deshmukh & Pandit (1968) have studied the microscopical characters of fruits of Helecteres isora but no report on its bark. Wahi et al (1979), Nayar (1979), Prasad et al (1964) and Prasad & Wahi (1965) reported absence of fibres, stone cells and presence of prismatic crystals in roots of Hemidesmus indicus. However, the present study revealed the presence of fibres and stone cells in the above drug. Wahi et al (1974) during their studies on Hibiscus rosa-sinensis leaf reported the presence of stellate and glandular trichomes, epidermis with a striated cuticle, stomata of both rannunculaceous and cruciferous types, as well as absence of starch grains and calcium oxalate

crystals. In the present study, however, presence of calcium oxalate crystals, ramunculaceous stomata and peltate trichomes have been observed in the above drug. The bark of Holarhena antidysenterica was reported to have the presence of stone cells, prisms of calcium oxalate crystals, starch grains and absence of phloem fibres (Prasad & Kaul, 1956), wherein the present investigation confirms the same except the absence of starch grains in the above drug. The present finding confirms the view of Mehra & Raina (1970) regarding the presence of stone cells in Mimusops elengi. Ghose & Hashmi (1979) observed that the distribution pattern of phloem fibres in tangential bands gives a characteristic look to the bark of M. elengi. Khosa & Prasad (1972) noted presence of unicellular trichomes fibres, cruciferous stomata & Prisms of calcium oxalate crystals in the leaf of Murraya koenigii. Presence of cluster crystals of calcium oxalate, unicellular trichomes, ramunculaceous stomata and absence of fibres in the above drug has been observed during this investigation. Datta & Sen (1969) found out the presence of calcium oxalate crystals and rubiaceous stomata in the leaf of Oldenlandia corymbosa, which agrees with the present findings. Presence of groups of stone cells & phloem fibres have been reported in the bark of Oroxylum indicum by Prakash & Prasad (1969), which was confirmed in the present study.

Paech & Tracey (1955) have suggested different solvents for flavonoids class such as n.butanol: 27% aqueous acetic acid; m-cresol : acetic acid : water; phenol : water & distilled water for the development of paper chromatograms and Rf values and colours were recorded under UV without spray and also when treated with ammonia, aluminium chloride & ferric chloride. Randerath (1968) has also indicated the Rf values & colour reactions of phenols, phenol aldehydes as well as phenol carboxylic acids on silica gel G layers in the solvents like benzene : dioxane : acetic acid; benzene : methanol : acetic acid; benzene and benzene : methanol. He also reported separation of derivatives of coumarin, flavone and hydroquinone on silica gel G layer with a mixture of toluene : ethyl formate :

formic acid and further separation of flavone glycoside with a mixture of ethyl acetate : methyl ethyl ketone : formic acid : water (5 : 3 : 1 : 1) while in the present work, ethyl acetate : formic acid & water have been used in the proportion of 8 : 1 : 1 by excluding methyl ethyl ketone & substituting its amount in ethyl acetate.

Rf values and colour reactions with vanilline - Hcl, folin ciocalteu of simple phenols & phenolic acids in solvents like acetic acid : chloroform & ethyl acetate : benzene on silica gel G and solvent benzene : methanol : acetic acid and 6% aqueous acetic acid on cellulose MN 300 have been studied by Harbourn (1973). He also recommended the method of separating and identifying simple phenolic, by TLC on silica gel G when run two dimensionally, first in 10% acetic acid in chloroform and second in 45% ethyl acetate in benzene as well as noting colours with folin ciocalteu & ammonia. Stahl (1969) utilised TLC for characterisation of animal & plant drugs as a finger print technique. He reported TLC of important anthraquinone drugs like cape aloes, frangula bark, cascara bark, rhubarb rhizome & senna leaf on silica gel G with a solvent ethyl acetate : methanol : water. He further demonstrated how TLC of silica gel G is suitable for distinguishing 'Hashish' extracts of different origin. He reported that crude drug can be detected and differentiated from closely related species by running the extracts of drugs on silica gel G layers in various solvents including ethyl acetate : formic acid : water (80 : 10 : 10) and detecting the spots by spraying with various chromogenic agents.

In the present finding, Thin Layer Chromatographic studies on the root extracts clearly showed how the methanolic extract of different roots species behave with the solvent systems and spray reagents. Roots of Viburnum foetidum, Caesalpinea crista, Maesa indica, Citrus medica, Vitex negundo, Curcuma zedoaria; leaf drugs like Annona squamosa, Calotropis gigantea, Leucas aspera, Cassia

fistula, Thespesia populnea, Nyctanthes arbor-tristis, Oldenlandia corymbosa, Murraya koenigii and bark drugs like Hydnocarpus wightiana, Machilus macrantha, Pterocarpus marsupium, Tamarindus indica, Moringa pterygosperma, Careya arborea, Nyctanthes arbor-tristis, Zizyphus jujuba, Mimusops elengi, Helicteres isora, Sterculia urens and Grewia microcos, showed almost the same Rf values in different spray reagents when run in a developing solvent toluene : ethyl formate : formic acid (75 : 24 : 1) which is a solvent for separation of flavonoid aglycons and phenols. Similarly, roots of Hemidesmus indicus, Arundinella gigantea, Pterocarpus marsupium, Cocculus macrocarpus, Ixora parviflora, Curcuma zedoaria; leaves of Pterocarpus marsupium, Tamarindus indica, Cassia fistula, Thespesia populnea, Oldenlandia corymbosa, Murraya koenigii and the barks of Spondias pinnata, Annona squamosa, Tamarindus indica, Nyctanthes arbor-tristis, Psychotria truncata, Zanthoxylum rhetsa, Allophylus cobbe, Helicteres isora showed almost the same Rf values in different spray reagents when run in developing solvent system toluene : chloroform : Acetone (40 : 25 : 35) indicating that the drugs contained flavonoid or phenolic constituents. Few of the root drugs like Momordica dioica, Arundinella gigantea, Leucas aspera, Citrus medica and Lygodium flexuosum showed compounds of Lichen present as seen from the TLC tables in the developing system No.I. Some root drugs like Arundinella gigantea, Leucas aspera, Paederia foetida, Grewia microcos; leaves of Calotropis gigantea, Ricinus communis, Thespesia populnea, Averrhoa bilimbi, Murraya koenigii, Mimusops kauki and the barks like Spondias pinnata, Ricinus communis, Cassia fistula, Ziziphus jujuba, Mimusops elengi, Ficus bengalensis, Sterculia urens, showed the presence of anthraquinone glycosides as seen from the results when run in solvent system benzene : ethyl formate : formic acid (75 : 24 : 1). However, seed extracts did not show favourable results for phenolic constituents as seen from the data collected during this study.

The presence of glycosides was noticed in the leaves of Leucas aspera, Tamarindus indica, Cassia fistula, Hibiscus rosa-sinensis, Nyctanthes arbor-tristis,

Oldenlandia corymbosa, Murraya koenigii, Lantana camara and roots of Caseara esculenta, Caesalpinea crista, Maesa indica, Ixora parviflora, Lygodium flexuosum, when they were run in solvent system ethyl acetate : butanone : formica acid and water (50 : 30 : 10 : 10).

Similar results were obtained in barks of Spondius pinneta, Polyalthea fragrans, Croton oblongifolius, Tamarindus indica, Careya arborea, Zanthoxylum rhetsa and Helectrus ixora.

The above results gave a finger print technique for the identification of the drugs, besides these results also confirmed the phytochemical screening test of the drugs.

TLC technique using ethyl acetate : formic acid : water (80 : 10 : 10) as developing solvent and boric acid - oxalic acid as spray reagent was used for the separation of 5-hydroxy flavonoids and it gave an indication for the presence of these compounds. Two dimensional paper chromatographic study revealed different types of flavonoids present in the drug by means of their locations of the spots as well as their colours. The results proved to be very good clues for the identity of the drugs based on fingure print technique.

Some of these colours were very prominent and therefore these drugs could be utilised for extraction of flavonoids.

Harborne & Hall (1964) reported on the systematic distribution and origin of anthocyanins by means of Rf values and colours using UV light in different developing solvents.

Casteel & Wender (1953) reported Rf values of flavonoid compounds by

paper chromatography in different solvent systems like ethyl acetate saturated with water, phenol saturated with water, m-cresol saturated with water, butanol : acetic acid : water (4 : 1 : 5), Isopropyl alcohol : water (3 : 2), acetic acid : water (3 : 17) & acetic acid : water (3 : 2) and also the colours produced when observed under UV light untreated as well as when sprayed with aluminium chloride, lead acetate & ferric chloride solutions. Howard et al (1972) have also reported a distributional data for 12 flavonoid in 23 taxa of Oenothera, 2 species of Calylophus and 1 species of Gaura.

Williams & Murray (1972) reported flavonoid variation in the genus Briza of family Graminae. Challice (1972) reported the distribution of leaf phenolics of a number of Pyrus interspecific hybrids by using different flavone and flavonol glycosides. Mabry et al (1970) have reported the distribution of flavonoid compounds in two dimensional paper chromatographic technique. This technique was found to be very effective and so used during present studies for identification purpose by giving out symbols for the locations of the spots. Similarly, when run in ethyl acetate : formic acid : water (80 : 10 : 10) and sprayed with boric acid - oxalic acid reagent, the flavonoids gave a brilliant fluorescence indicating presence of 5-hydroxy flavonoids. From the chromatographic study, the plants used for the present works, proved to have some pharmacological properties of flavonoids and other phenolic substances. As far as phytochemical survey of flora is concerned quite a few scientists have worked on these aspects. Prabhakar Rao et al (1985) studied the phytochemical survey of Mayurbhanj, Ganjam & Puri district (Orissa) for tannins, saponins, flavonoids & alkaloids. Kapoor et al (1969, 1971 & 1972) surveyed the Indian plants for saponins, alkaloids & flavonoids. Most of these results tallies with our results. Kapoor et al (1972) in their earlier findings reported that flavonoids are absent in bark of Careya arborea and leaves of Tamarindus indica and Lantana camara, while the flavonoids were found to be present in the Goa species in the present investigation. In Viburnum

foetidum roots, Kapoor et al (1972) reported that alkaloids are absent and flavonoids to be present but the present studies found that the alkaloids are present and flavonoids absent in the above drug. Kapoor et al (1975) have published some phytochemical screening data on plants from Goa region particularly from Ponda, Mollem, Valpoi & Panaji which does not cover the Morlem forest. They have reported Oldenlandia corymbosa to contain flavonoids however drug collected for present investigation failed to give positive test for it. Although Bhattacharjee & Das (1969) have reported that the bark extracts of Pterocarpus marsupium were devoid of alkaloid and tannin, however present study gives positive test for tannins. Khastgir et al (1960) reported absence of alkaloid in Oldenlandia corymbosa leaves while Atal et al (1978) reported absence of tannins in the same drug. Kureel et al (1969) reported presence of alkaloid in leaf of Murraya koenigii. Atal et al (1978) reported tannins to be absent in bark of Moringa pterygosperma. Gupta et al (1976) reported that leaves of Mimosa pudica contained alkaloids, while Atal et al (1978) reported that tannins were absent in leaves of Mimosa pudica. Atal et al (1978) reported presence of tannins in whole plant of Maesa indica excluding roots. All the above results confirm the present findings. Saxena (1975) reported that leaves of Ixora parviflora did not show presence of tannins, flavonoids & alkaloids while the present study on its roots showed presence of tannins & flavonoids and absence of alkaloids. Usually tannins are the compounds present in fruits and barks but in fruits of Helecteres isora, Deshmukh & Pandit (1968) revealed the presence of tannins however, the present study on its bark showed absence of tannins. Atal et al (1978) have, however, reported that whole plant of H. isora excluding roots was devoid of tannins which confirms the present findings. Tannins have been reported to be present in the leaves of Hemidesmus indicus by Daniel et al (1978) which results are in agreement with the present findings. Verma et al (1967) reported that different extracts of Hibiscus rosa-sinensis revealed presence of alkaloids and absence of tannins, which confirms the findings of this investigation. According to recent review by Chaturvedi et al (1980, 1981) alkaloids have

been reported to be present by different workers in Holarrhena antidysenterica which confirms the present results. Bhattacharjee & Das (1969) and Kapoor et al (1969) have reported the absence of tannins and flavonoids in bark of Holarrhena antidysenterica. However, Daniel et al (1978) reported presence of tannins in the leaves of Holarrhena antidysenterica. The present finding on its bark showed presence of tannins & absence of flavonoids. It has been observed that phytochemical screening of plants from Goa region especially from Morlem forest of Sattari taluka, Goa has not been completed so far and the above results displayed a chemical identity for these plants.

Out of 70 herbal samples studied for their phytochemical screening, taxonomy and chemotaxonomy using phenolic constituents and especially flavonoids as markers for identification of drugs, it was observed that the plant Measa indica was a prominent and promising drug among them. This plant is grown especially in the area of Sattari taluka and moreover it is being extensively utilised by the local people for various ailments in indigenous system of medicine. On literature survey, this plant showed a scanty work. Only the leaves have been worked out while roots have not been studied so far. Moreover, the chemical studies of the roots by chromatography revealed it as a chosen drug for the purpose. Kapoor et al (1983) reported absence of flavonoids in Measa indica which was labelled as doubtful source. The present study showed presence of flavonoid. Desai et al (1973) observed that the hexane extract of Measa indica (whole plant) yielded  $\beta$ -sitosterol, which confirm the present finding. Desai et al (1975) have further reported that acetone extract of seeds of Measa indica yielded measaquinone. The present study showed steroid and flavonoid. According to Atal et al (1978), the whole plant of Maesa indica excluding roots contains tannins, while present study on roots showed presence of tannins. Prabhu & Venkateswarlu (1971) concluded that the extraction of Maesa macrophylla leaves with ethyl alcohol yielded quercetin & an impure yellow residue (m.p. 222 - 226° C) which on hydrolysis gave quercetin and

galactose. The entire plant of Maesa montana excluding roots showed presence of tannins as reported by Atal et al (1978). Aziz Ahmad & Zaman (1973) reported that the light petroleum extract from leaves of Maesa indica yielded  $\beta$ -sitosterol while the ethyl acetate soluble fraction yielded quercetin - 3 rhamnoside.

Present study is limited to the roots of Maesa indica, which were collected from Morlem forest, Goa. The chemical examination of this root yielded (1) two sterols from petroleum ether extract viz.  $\beta$ -sitosterol & stigmasterol; (2) an aglycone from ether extract, the structure of which could not be elucidated due to the scaracity of the compound from the plant material. It tentatively showed to be a flavonol aglycone with two hydroxy groups at 6 and 8 positions as its IR graphs did not compare with the known compounds documented in Aldrich catalogue. (3) Flavonol glycoside from ethyl acetate fractions which was confirmed by spectral data as rutin. This species from Goa is ~~for~~ the first time reported to contain the above compounds.

### CONCLUSIONS

On the basis of the above studies on the indigenous plants and their products from Goa, following salient features can be of significant importance:

- 1) Goa is found to be rich in the growth of medicinal plants because of climatic and environmental conditions.
- 2) The medicinal plants have been systemetically described morphologically & taxonomically, during the present investigation.
- 3) Microscopical study revealed good comparison between plant samples. The anatomical similarity between Apocynaceae and Asclepiadaceae confirmed that these families are closely related. Malvaceae showed close affinity with Tiliaceae, Flcourtiaceae and Sterculiaceae. This study laid down standards for plants samples.
- 4) Thin Layer Chromatography study revealed good comparison between the plant

samples especially when run in eight developing solvent systems of the choice of the phenolic substances. It served as a finger print technique for the identification & characterisation of the plant samples.

5. Thin Layer Chromatography study using ethyl acetate : formic acid : water (8 : 1 : 1) and with boric acid - oxalic acid spray as well as two dimensional paper chromatography study revealed the presence or absence of flavonoid class of compounds and the spots occurred with different colours served as markers for the identification of the drugs.
6. Phytochemical screening of these plants from the Goa region confined to Morlem forest labelled the plant samples with certain chemical entities. Based on the constituents of the plants, it can be further studied for phytochemical & pharmacological purposes.
7. The plant Maesa indica selected for phytochemical study revealed for the first time the presence of sterols and flavonoids and based on these aspects other plants can also be taken up for further study.
8. The results encountered in the thesis indicate the vast potential of this untapped medicinal resources from Goa region.

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APPENDIX  
OTHER RESEARCH PUBLICATIONS

# Effect of some Hydrocolloids on the Crystal Size of Sulphaguanidine by Solvent Change Method

B. S. NATH and R. V. GAITONDE

Goa College of Pharmacy, Panaji, Goa.

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The effect of hydrocolloids such as polyvinyl pyrrolidone (PVP), carboxymethyl cellulose (CMC), gelatin and sodium alginate (0.001 and 0.005%) on the particle size of sulphaguanidine produced by solvent change method of crystallization was studied. Hydrocolloids produced significant reduction in crystal size probably by the formation of a surface film around the crystal nuclei.

AMONG the different techniques of crystallization, solvent change method has been widely used.<sup>1</sup> Several factors affecting the particle size of sulphadiazine produced by solvent change method under normal and turbulent agitational conditions have been reported.<sup>2,3</sup> As the crystal size and shape are extremely important in pharmaceutical preparations, the consistency of crystal habit should be controlled. The influence of various added surface active agents to control the crystal size of sulphaguanidine<sup>4</sup> and sodium urate<sup>5</sup> has been reported. Polyelectrolytes like PVP and CMC have been reported to be useful for retarding crystal growth of sulphathiazole<sup>6</sup> and barium sulphate.<sup>7</sup> *In vitro*, precipitation of poorly soluble drugs, like phenyl hydantoin from non-aqueous vehicles in human plasma was recently reported.<sup>8</sup> The effect of PVP, CMC, gelatin and sodium alginate on the crystal size of sulphaguanidine by solvent change method has been investigated.

## EXPERIMENTAL

**Materials:** Sulphaguanidine I.P., dimethyl formamide (BDH), polyvinyl pyrrolidone 40,000 M.W. (BDH), carboxymethyl cellulose (BDH), gelatin (E. Merck) and sodium alginate (USSR).

### Methods:

**Crystallization of sulphaguanidine:** Weighed quantities of sulphaguanidine to

yield 10 and 20% w/v solutions were dissolved in 10 ml. of dimethyl formamide and then added slowly to 250 ml. of water. The contents were stirred at 52 rev./min. for 60 minutes and the separated crystals were filtered, washed and dried. Similarly, for overnight samples after the addition of the solution of sulphaguanidine in dimethyl formamide, the contents were stirred for one hour and kept for 24 hours and then filtered, washed and dried. To find out the effect of hydrocolloids, instead of pure water, 250 ml. of water containing 0.001 and 0.005% v/v of each of the hydrocolloids was used as non-solvent, and the crystallization of sulphaguanidine was carried out as described before. The particle size distribution of the crystals was determined microscopically. Not less than 300 crystals were measured. Infra red spectra of pure drug, hydrocolloids and nucleated drug in presence of hydrocolloids were taken by Pellet Bromide method using Perkin Elmer instrument.

X-ray analysis of crystal samples was made by using Philips x-ray unit and the photographs were taken by using a Debye-Scherrer Camera, using copper k radiation and exposed for 2 hours.

**Other physical properties:** Surface tensions of water samples containing hydrocolloids at the concentration of 0.001 and 0.005% were determined at room temperature by using Traube's Stalagmometer. Melting point of the

TABLE 1.—EFFECT OF HYDROCOLLOIDS ON THE SIZE OF THE CRYSTALS OF SULPHAGUANIDINE PRODUCED BY SOLVENT CHANGE METHOD

Hydrocolloids	Mean crystal length in microns*			
	10% drug		20% drug	
	1 hr**	24 hr	1 hr	24 hr
PVP	(a) 10.78	9.045	8.807	7.835
	(b) 9.89	8.803	7.53	6.93
CMC	(a) 12.39	11.792	7.955	8.645
	(b) 9.36	9.22	6.78	7.222
Gelatin	(a) 13.95	13.175	10.632	10.73
	(b) 12.37	11.34	9.95	9.335
Sodium alginate	(a) 10.27	9.42	6.19	6.50
	(b) 7.27	7.442	5.047	5.312
Control	53.53	43.175	43.175	53.23

Concentration of Hydrocolloid (a) 0.001 and (b) 0.005%.

\* Mean of 300 crystals of sulphaguanidine, measured microscopically.

\*\* Time intervals of crystallization.

crystals was determined by using Thiel's tube. compared with the tabulated values.

#### RESULTS & DISCUSSION

The data obtained were subjected to a randomised block analysis of variance according to standard procedure.<sup>9</sup> F values calculated from the data were

The crystals of sulphaguanidine obtained were acicular in shape and were assigned to size classes on the basis of

TABLE 2.—ANALYSIS OF VARIANCE SHOWING THE EFFECT OF SOLUTE CONCENTRATION AND TWO TIME INTERVALS (ONE HOUR AND OVERNIGHT KEEPING) ON THE CRYSTAL SIZE OF SULPHAGUANIDINE PRODUCED BY SOLVENT CHANGE METHOD AT TWO CONCENTRATION LEVELS OF ADDED HYDROCOLLOIDS

Source of Variance	Sum of Squares		Degrees of freedom	Mean sum of squares		Variance ratio	
	a	b		a	b	a	b
	Between the solute concentrations	34.598		19.666	1	34.598	19.666
Between time intervals	0.693	0.374	1	0.693	0.374	1.573	2.938
Interaction	1.264	0.184	1	1.264	0.185	—	—
Total of conditions of crystallization	36.555	20.225	3				
Between the Hydrocolloids	35.570	40.360	3	11.856	13.453	26.91**	105.6**
Error	3.963	1.145	9	0.4403	0.1273		
Total	76.088	61.730	15				

a:—Hydrocolloid Conc. 0.001%, b:—Hydrocolloid Conc. 0.005%.

\*\*.—Significant at 1% level.

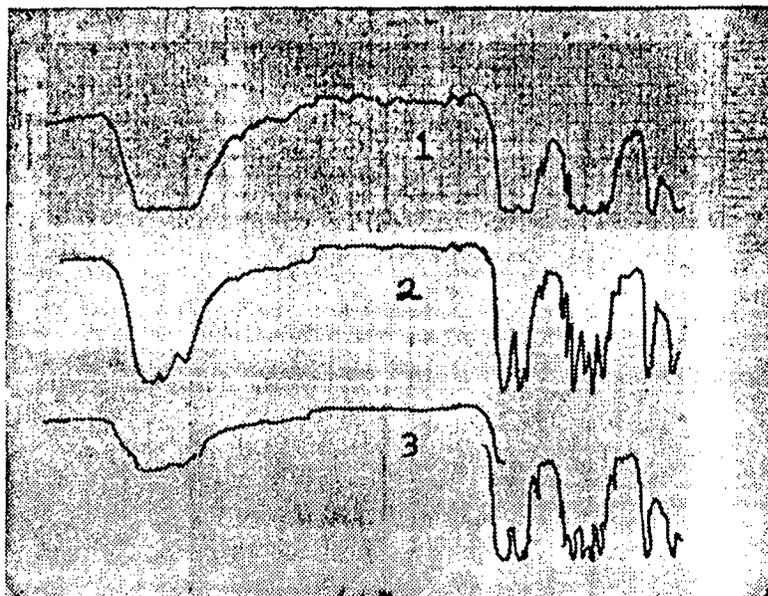


Fig. 1. Infra red spectra of pure sulphaguanidine (1.), and crystals nucleated in presence of PVP (2), CMC (3), gelatin (4) and sodium alginate (5) by solvent change method.

their length. The mean length of crystals produced in all 36 series of crystallizations are shown in Table 1. The crystals formed appeared to be delicate due to their small diameter. At both the drug concentrations (10 and 20% w/v) the crystals of sulphaguanidine produced without any added hydrocolloids showed highly skewed distribution, whereas those formed in presence of hydrocolloids showed uniform growth. Further, the size of the crystals produced significantly differed among themselves between two concentrations of hydrocolloids (F being 26.91 and 105.6 at df 3/9 for 0.001 and 0.005% respectively as shown in Table 2). The crystals were identified

as of sulphaguanidine by infra red spectrum. Fig. 1 shows a comparison of spectra of pure drug and drug nucleated in presence of 4 hydrocolloids. With the exception of some minor broadening of bands and a decrease in the absorption intensity, the spectra were identical. Among the 4 hydrocolloids, PVP showed less influence on the absorption intensity and CMC still less. New bands characteristic of the hydrocolloids were shown. It appears that hydrocolloids were preferentially adsorbed on the crystal nuclei and formed an interfacial barrier around the nuclei. The melting points for pure and crystal nucleated in presence of hydrocolloids showed good comparison.

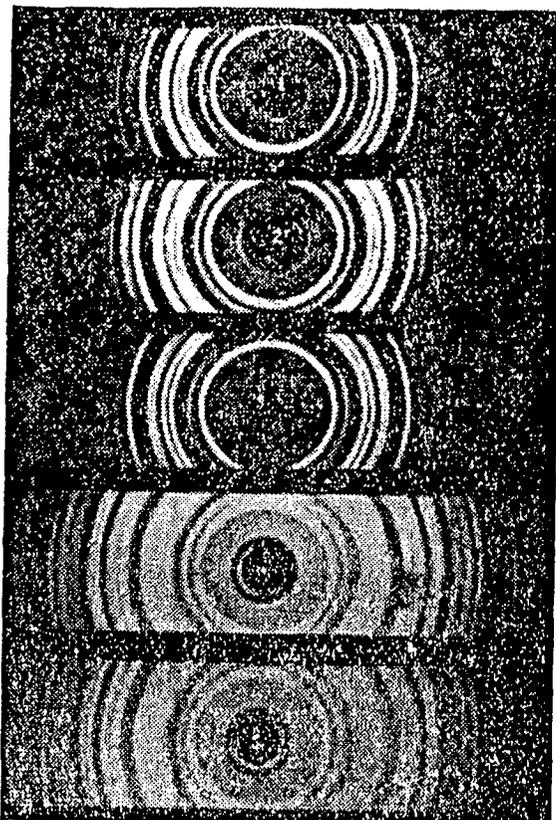


Fig. 2. X ray diffractograms of pure sulphaguanidine (1) and crystals nucleated in presence of PVP (2), CMC (3), gelatin (4) and sodium alginate (5) by solvent change method.

The reported m.p.  $193^{\circ}$  was obtained for the pure sample and the nucleated samples melted at  $190^{\circ}$ . The difference of  $3^{\circ}$  as well as an observed discolouration of the nucleated drug samples upon melting may be attributed to traces of hydrocolloids adsorbed on the crystal or due to possible inclusion of trace amounts of polyelectrolytes upon crystal formation. Surface tension values (dynes/cm<sup>2</sup>) for water containing hydrocolloids were as follows; PVP 67.71, 66.71; CMC 66.71, 66.61; gelatin 68.58, 67.85 and sodium alginate 66.49, 66.85. The X-ray diffractograms of pure drug as well as of the crystals nucleated in presence of hydrocolloids are shown in Fig. 2, which are identical in all respects, except for a few additional bands corresponding to the added hydrocolloids. Hence, no polymorphism but only change in the crystal size seems to take place as evidenced by the increase in the width of the bands. In the case of crystals nucleated in

presence of gelatin and sodium alginate, the difference in the pattern can be attributed to the influence of patterns of sodium alginate and gelatin, which are having definite x-ray patterns of their own. The drug concentration in dimethyl formamide was found to affect significantly the size of crystals. At both levels of concentrations of hydrocolloids the difference in crystal size between one hour and 24 hours samples was not significant as shown in Table 2. The effect of hydrocolloids in reducing the crystal size, therefore, cannot be attributed to any single factor in solvent change crystallization process. The charges of individual hydrocolloids also probably play a role in their adsorption on the crystal surface.

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## Antimicrobial Activity of Metallic Salts of Arabic Acid

R. V. GAITONDE  
Goa College of Pharmacy,  
Panaji-Goa.

### ABSTRACT

The use of mercury, copper, iron and lead has been mentioned in Ayurveda<sup>1</sup>. The inorganic salts of the metals were toxic and caused irritation. They precipitated proteins due to high concentration of metallic ions. They could not be used on the skin over a long period of time. Hence attempts were made to overcome the above disadvantages by incorporating the metals like mercury, silver and copper in complex organic acid like arabic acid prepared from gum acacia. These metallic salts of arabic acid were then screened against different bacteria and fungi, and they were found to possess both antibacterial and antifungal properties.

### INTRODUCTION

Gum arabic as found in nature is a mixture of calcium, magnesium and potassium salts of arabic acid<sup>2,3</sup>. It contains 70.40 per cent of arabic acid and 17.6 per cent of water<sup>4</sup>. There are several methods for the preparation of arabic acid<sup>5,6</sup> and salts of arabic acid<sup>7,8</sup>. The present work is mainly focussed on the screening of the anti-microbial activity of metallic salts of arabic acid as these salts have not been studied so far for their antimicrobial activity.

### METHOD

#### Preparation of arabic acid

A 10 per cent gum acacia solution was prepared in 0.1N hydrochloric acid by boiling on water bath for one hour. The solution was then filtered and dialysed. It was found that no calcium, magnesium, and potassium ions could be detected after 48 hrs. dialysis, while gum acacia originally contained 0.058 per cent Potassium, 0.8076 per cent calcium and 0.7409 per cent magnesium. Arabic acid was then precipitated by adding acetone to the above dialysed gum acacia solution, filtered and dried in vacuum desiccator. The percentage yield was 68 per cent.

#### Preparation of Metallic Salts of Arabic Acids

Arabic acid was dissolved in the required amount of 0.1N sodium hydroxide solution and dialysed for 12 hrs. to free from sodium ions. This sodium arabate solution was then complexed with equivalent amount of mercury nitrate solution and the mixture was maintained at 50°C. for 3 hrs., filtered and then dialysed to free from mercury ions. The dialysed mercury arabate solution was then precipitated, filtered and dried as above. In the same manner, silver arabate and copper arabate were prepared by complexing with silver nitrate and copper nitrate solution respectively. Copper arabate and silver arabate were estimated for their copper and silver content by I.P. method and mercury arabate was estimated for its mercury content by B.P.C. 1963 method. It was found to contain 0.4133 g per cent of copper, 0.6905 g per cent of silver and 0.2507 g per cent of mercury ion.

#### Preparation of Test Samples

A 1 per cent of the metal arabates was prepared in distilled water aseptically and evaluated for antimicrobial activity by cylinder plate method of florey and chain<sup>9</sup>.

## Standards

Penicillin sodium I.P. (2.5 units/ml.) and salicylic acid 1 per cent were used as standard substances for antibacterial and antifungal activities respectively.

The oxid Nutrient agar and Sabourand's medium were used for growing bacteria and fungi respectively. The experiments were conducted in Petri dishes (150 mm. x 20 mm.) containing 50 ml. of nutrient medium. An actively growing 24 hrs. old culture of the

test organisms was used as inoculum. Short open ended steel cylinders (8 mm. O.D.) were placed on the surface of medium and slightly pressed in the medium. They were then filled with required quantity of metal arabate solution. The plates were then refrigerated for 2 hrs. to allow the diffusion of metal arabate solution and then incubated for 24 hrs. at 37°C. The diameter of zone of inhibition was then measured. Control and standard experiments were also run simultaneously. Observations are recorded in Table I and Table II.

TABLE — I

### ANTIBACTERIAL ACTIVITY OF METAL ARABATES COMPARED WITH PENICILLIN SODIUM I.P.

Organism	Distilled water (Control)	Mean diameter** of zone of inhibition (mm)*			
		Mercury arabate 1%	Silver arabate 1%	Copper arabate 1%	Penicillin sodium I.P. 2.5 units/ml.
<i>Escherichia coli</i>	—	10	—	—	—
<i>Bacillus subtilis</i>	—	14	13	—	25
" <i>anthracis</i>	—	14	12	10	20
" <i>pumilus</i>	—	13	10	8	18
<i>Salmonella typhosa</i>	—	13	10	7	—
<i>Staphylococcus aureus</i>	—	12	9	7	18
<i>Micrococcus pyogenes</i>	—	16	14	11	22
<i>Proteus vulgaris</i>	—	14	10	—	—

TABLE — II

### ANTIFUNGAL ACTIVITY OF METAL ARABATES COMPARED WITH SALICYLIC ACID.

Organism	Distilled Water	Mean diameter** of zone of inhibition (mm)*			
		Mercury arabate 1%	arabate Silver 1%	Copper arabate 1%	Salicylic 1%
<i>Asperigillus niger</i>	—	20	18	16	34
" <i>flavous</i>	—	19	16	14	34
<i>Trichophyton equingia</i>	—	16	12	9	37
<i>Fusarium oxysporum</i>	—	10	—	—	30
<i>Cryptococcus neoformans</i>	—	18	16	12	27

\* Including the diameter of the cylinder.

\*\* Mean of three readings.

## DISCUSSION

In vitro, antibacterial and antifungal activities, of some metal arabates prepared from arabic acid of gum acacia were determined using cylinder plate method against some bacteria and fungi. The maximum antimicrobial activity was observed against micrococcus pyogenes and Asperigillus niger as compared with Penicillin and Salicylic acid. From Table I and Table II it is evident that the metallic salts prepared from arabic acid possess Potent antibacterial and antifungal activities.

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# In Vitro, Comparison of Acid consuming capacity, Specific Rate constant and Buffering capacity of Commercial Antacid Tablets.

R. V. GAITONDE  
& B. S. NATH  
Goa College of Pharmacy,  
Panaji-Goa.

## ABSTRACT

Eleven commercial antacid tablets containing various amounts of different antacid ingredients were tested in Vitro for acid consuming capacity, specific rate constant and buffering capacity in maintaining an elevated PH which varied over a wide range among the samples tested.

## INTRODUCTION

Gastric antacids are drugs which are used for the treatment of hyperchlorhydria and peptic ulcer. The properties of the antacids, especially alumina gel, have been reported, to be effected during preparation by several factors<sup>1-4</sup>. The effectiveness of an antacid formulation depends not only on its ability to neutralise gastric hydrochloric acid immediately after dosing but also on its ability to maintain intragastric ptt at an elevated level favourable to ulcer healing and above that optimal for pepsin activity. The additives added during formulation of antacid tablets may have some effect on the acid properties. Effect of some granulating agents on antacid properties of dried aluminium hydroxide gel has been reported.<sup>5</sup> The marketed antacid preparations with varied amounts of different ingredients, prepared with different binding agents were therefore tested for their antacid properties.

## EXPERIMENTAL

In order to carry out the tests, code letters were assigned to each of the eleven commercial antacid tested. Samples from different lots of each antacid tablet were powdered and a weighed quantity of powder was taken for all the tests.

## METHOD

Acid consuming capacity was determined as per I.P. method and was calculated in terms of volume of 1 N acid consumed per gram of sample using the formula reported in our pre-

vious article<sup>5,6</sup>. Buffering capacity was determined as per the method recommended by Hobert et al<sup>7</sup>, using PR 9405 L PH meter of Philips make and was calculated by the method reported in our previous article<sup>5</sup>.

Specific rate constant was determined and calculated by the method reported in our previous article<sup>6</sup>.

## RESULTS AND DISCUSSION

The wide variation in acid consuming capacity among the antacid formulations can be explained by the fact that the formulations are combinations of different antacid ingredients having different acid consuming potencies or contain the same ingredients in different ratios or chemical forms. Formulation F had the highest acid consuming capacity and formulations D & H had the longest duration of action. However, the correlation between acid consuming capacity and buffering capacity was not close with most of the other formulations. Of course, these in Vitro, buffering capacity data cannot be directly applied to as in Viva system, because while simulated gastric fluid was added to the in-vitro system, at a constant rate, the stomach secretes gastric acid at a variable rate. The specific rate constant values inversely indicate the rate at which the acid was neutralised by the sample. Higher the values of specific rate constant, the lesser would be the acid neutralised by samples in that time interval. Lastly, it can be concluded that there is a considerable difference among the commercial antacid preparations tested in

**TABLE — 1**  
**ACID CONSUMING CAPACITY AND SPECIFIC RATE CONSTANT OF**  
**ELEVEN COMMERCIAL ANTACID TABLETS**

O. 1 N Hcl. Consumed by 1 gm. of sample

in give replicate determination.

Sample symbol	Acid consuming capacity in C. C.						Specific rate constant $K = \text{Min}^{-1}$
	1	2	3	4	5	Mean	
A	182.8	186.8	189.2	188.8	190.0	187.5	0.05101
B	87.6	84.4	87.2	84.8	86.0	86.0	0.03445
C	127.2	128.4	127.6	127.2	127.6	127.6	0.04220
D	164.4	163.6	163.6	163.2	163.6	163.7	0.06722
E	94.8	94.0	94.0	93.6	94.0	94.1	0.02880
F	190.8	192.0	192.0	190.6	193.2	191.7	0.05191
G	87.2	85.2	88.0	83.6	84.0	85.6	0.03793
H	184.0	184.0	187.2	187.2	187.6	186.0	0.04355
I	146.0	143.6	142.8	143.2	142.0	143.5	0.04969
J	150.0	150.0	149.2	149.6	149.6	149.7	0.04412
K	91.2	89.2	91.2	86.8	85.2	88.7	0.04898

**TABLE — 2**  
**BUFFERING CAPACITY OF ELEVEN COMMERCIAL**  
**ANTACID TABLETS**

Sample symbol	pH at time intervals of minutes.													
	0.5	2	4	6	8	10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90
A	1.6	1.65	1.8	1.85	2.1	2.35	2.8	3.6	3.3	3.1	2.9	2.7	—	—
B	1.5	1.65	1.7	1.8	1.95	2.1	2.65	3.4	3.2	3.1	2.75	—	—	—
C	1.3	1.5	1.8	2.3	3.0	3.35	3.45	3.65	3.2	3.0	2.7	—	—	—
D	1.5	1.8	2.0	2.3	2.9	4.0	4.2	4.1	4.0	3.7	3.4	3.0	2.7	—
E	1.3	1.4	1.5	1.6	1.7	2.3	2.7	3.2	3.0	2.7	—	—	—	—
F	1.8	2.7	3.7	4.1	4.2	4.3	4.0	3.8	3.6	2.9	2.8	2.75	—	—
G	1.5	1.6	1.85	1.95	2.0	2.4	2.8	3.3	3.0	2.7	—	—	—	—
H	1.5	1.6	1.8	1.9	2.0	2.4	3.8	4.0	3.9	3.7	3.5	3.0	2.75	—
I	1.5	1.65	1.7	1.8	2.0	2.2	2.8	3.3	3.0	2.7	—	—	—	—
J	1.6	1.9	2.45	2.9	3.4	3.65	3.2	3.0	2.7	—	—	—	—	—
K	1.7	1.8	1.9	2.0	2.2	2.45	2.85	3.2	2.9	2.7	—	—	—	—

acid consuming capacity, and in ability to maintain an elevated ptt in a dynamic in vitro system.

**ACKNOWLEDGEMENTS**

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# PREPARATION AND FACTORS INFLUENCING THE DIPHENHYDRAMINE HYDROCHLORIDE CARRAGEENAN (TYPE I) COMPLEX

B.S. Nath, K. Purushotham Rao & R.V. Gaitonde  
Department of Pharmaceutics, Goa College of Pharmacy, Panaji.

At 1 : 1 stoichiometric ratio carrageenan type I was found to form a free flowing complex at room temperature with diphenhydramine hydrochloride when added as dry powder or in solution. pH of 5.6 was found to be optimum for better yield and drug payload when pH effects were investigated. The complex was found to dissociate the drug within a period of three hours in simulated gastric, pancreatic fluids and in water. The release data when plotted was found to obey Higuchi's square root law.

In addition to active drug formulations contain other ingredients hither to considered to be inert. Several reports have shown that added excipients will interact in oneway or the other with the active ingredients and effect the bioavailability<sup>1,2</sup>. Natural gums and other cellulose derivatives were found to interact from highly insoluble complexes with antihistamines and other drugs with little product applications. The interacting tendencies of carrageenan type I (80% kappa and 20% lambda varieties with a view to isolate a soluble complex of diphenhydramine hydrochloride was studied under a variety of experimental conditions and recovered as dry powder and further characterised for its flow behavior. The in vitro drug release was studied in water, simulated gastric and pancreatic fluids.

## EXPERIMENTAL

Materials :—Carrageenan type I—Sigma Chemicals (USA), diphenhydramine hydrochloride—I.P., Bromo-

thymol blue—E. Merck, citric acid—BDH, Sodium-phosphate dibasic—Sarabhai, chloroform—I.P., Hydrochloric acid—E. Merck were used.

**Preparation and isolation of Carrageenan diphenhydramine hydrochloride complex :** A quantity of 25 ml uniformly dispersed gum solution (2%w/v) in a 100 ml beaker to which a quantity of 25 ml of the drug solution (2%w/v) in distilled water, was added with stirring at a speed of 100-150 rpm at room temperature (28°C). The precipitate which was formed immediately was allowed to stand for a period of 10 minutes and filtered through whatman no. 1 filter paper. The filtrate was collected to last drop in which the unreacted drug content was determined colorimetrically by adopting acid-dye method.<sup>4</sup> The precipitate was dried as 60°C for 3 hours and pulverised in a glass mortar for further characterisation.

The complex was also prepared by adding the drug in dry form to a quantity of 25 ml of 2% gum solution.

**Effect of pH on the yield and drug payload of the complex :** was determined by carrying out the reaction in McIlvaine buffers<sup>5</sup> of various pH values such as 2.2, 3.6, 4.6, 5.6, 6.6 and 7.6 for dissolving the gum. In these experiments the drug was added in dry form.

**Physico-chemical properties :** Size and size distribution of the complex was determined by seive analysis

Table I

Effect of mode of addition of Diphenhydramine Hydrochloride on the extent of binding to Carrageenan

S. No.	Indirect				Direct			
	Drug free mgs	Drug in Complex mgs	Dried recovered Complex mgs	Drug bound mg/gm	Drug free mgs	Drug in Complex mgs	Recovered Complex mgs	Drug bound mg/gm
1.	302.94	197.06	425.313	463.3294	245.548	254.452	487.578	521.8693
2.	302.94	197.06	425.701	462.9071	249.668	250.323	495.656	505.0519
3.	302.72	197.23	428.062	456.1956	249.668	250.332	491.650	509.1671
4.	304.14	195.86	425.808	459.9726	251.568	248.432	494.676	492.1039
5.	302.94	197.06	420.362	468.7864	249.668	250.332	485.220	515.9144
Mean	303.136	196.864	425.0492	462.2312	249.224	250.776	490.946	508.8213

Drug added is 500 mg and Carrageenan taken in 500 mg.

Table II

The effect of solution pH on the extent of binding of Diphenhydramine Hydrochloride to Carrageenan

pH	Diphenhydramine Hydrochloride			
	Drug free mgs	Drug in Complex mgs	Weight of Complex mgs	Drug bound mg/gm
2.2	284.496	225.504	454.944	473.694
3.6	270.506	229.494	476.612	488.897
4.6	264.668	235.332	474.234	496.236
5.6	255.328	244.672	482.126	507.486
6.6	283.784	216.216	450.412	483.040
7.6	294.88	205.12	447.828	458.623

Drug added is 500 mg. Carrageenan taken 500 mg in 25 ml of buffer solutions.  
Each reading is mean of 5 replicates.

using "Endicot" sieves 10, 20, 44, 60, 100, 120 and 170 with shaking time of 30 minutes using a mechanical shaker. True density was determined using a specific gravity bottle with toluene as immersion fluid at 28°C. Bulk density was determined by adopting the reported method of Butler and Ramsey.<sup>6</sup> Tap density was found by tapping a weighed amount of the complex in a 10 ml measuring cylinder using a mechanical tapping device (120 taps/min). The per cent bed porosity values were computed from true and bulk densities. The angle of repose (Theta) was determined by using Pilpel<sup>7</sup> cylinder method. Moisture content was determined by using infra red moisture balance. Rate of packing from loose to tight packing was determined as per reported method.<sup>8</sup> Powdered X-ray diffractograms were taken

using PW 1010 Philips X-ray diffractometer with CuK radiation and Nickel filter at scanning speed of 2°/min and scanning range ( $2\theta$ ) of 6-70°. Infra red spectra was taken by pellet bromide method using perkin-Elmer spectrometer.

**In vitro dissolution of the complex:** was determined in water, simulated gastric and pancreatic fluids by following beaker and stirrer method of Levy and Hays<sup>9</sup> by taking a quantity of 50 mgs accurately weighed complex tied in a muslin cloth bag and 250 ml of respective dissolution fluids. A 10 ml samples were withdrawn at each 30 minutes interval upto a period of 3 hours and immediately replaced by some quantity of fresh dissolution fluids. The drug released at each interval of time

Table III

Analysis of variance showing the effect of solution pH on the extent of binding and yield of diphenhydramine hydrochloride to Carrageenan

Source of variance	Sum of Squares		Degrees of freedom (Df)		Mean sum of Squares		Variance ratio		Tabulated value
	a	b	a	b	a	b	a	b	
Between pH values	6298.8748	5562.2825	5	5	1259.7749	1112.45	7.7776	20.59	3.1
Between replicate	2432.0499	644.7929	4	4	358.0225	161.198	2.2101	2.68	2.87
Error	3239.783	1080.4283	20	20	161.989	54.0219			
Total	10970.707	6642.7198	29	29					

a=drug bound      b=yield  
Significance at 5% level of Probability      P=0.5 at Df 5 and 20

Table IV

**In Vitro dissolution of Carrageenan Complex with Diphenhydramine Hydrochloride in water, simulated gastric and intestinal fluids**

Time in minutes	Water		Simulated gastric fluid PH 1.1		Simulated Intestinal fluid pH 7.6	
	C.R.	%C.R.	C.R.	%C.R.	C.R.	%C.R.
30	6.68	26.70	15.43	61.67	7.31	29.22
60	9.47	37.85	17.76	70.98	9.14	36.53
90	11.81	47.20	28.49	73.90	10.73	42.89
120	13.57	45.24	19.49	77.90	12.18	48.68
150	14.98	59.87	20.42	81.61	13.44	53.72
180	15.40	61.55	20.98	83.83	14.74	58.91

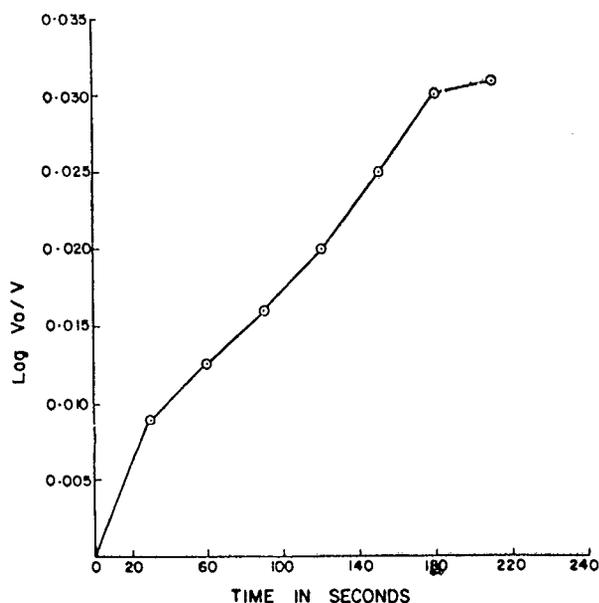
Each 50 mg of complex represents 25.02 mg of active drug.  
C.R. = Cumulative release.

was determined colorimetrically.

### RESULTS AND DISCUSSION

The effect of mode of addition of diphenhydramine hydrochloride to carrageenan solution on the yield and drug payload of the resulting complex was investigated and the results are shown in table I. The yield and payload in mg and mgs/gm or dry complex in direct and indirect method of drug addition were 490.96, 508.82 and 425.05, 462.24 respectively. So, the results showed that the direct addition of drug to gum solution favoured better yield and drug payload.

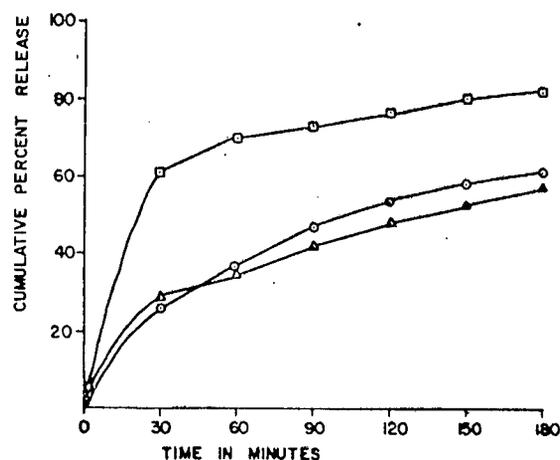
Fig. I



RATE OF PACKING OF DIPHENHYDRAMINE HYDROCHLORIDE  
CARRAGEENAN COMPLEX PARTICLES

The result shown in table II revealed that at pH 5.6 maximum amount of yield with good drug payload was obtained in compare to any other pH value studied. The reason may be attributed to the least solubility of the complex at that pH. Perhaps pH 5.6 may be considered as the isoelectric point of the complex. Precisely to know the effect of different pH values on the complex formation, analysis of variance was carried out on both the values of yield and drug payload at each pH value and shown in table III. Variance between the different pH values was found to be significant both in the case of yield as well as drug payload as shown by F values obtained which were 7.7769 and 20.59 respectively. These values were far greater than the tabulated value of 3.1 to be significant at P70.5 with df 5 and 20.

Fig. II



IN VITRO RELEASE OF DRUG FROM DIPHENHYDRAMINE HYDROCHLORIDE -  
CARRAGEENAN COMPLEX IN WATER (□-□-□), GASTRIC FLUID (○-○-○),  
INTESTINAL FLUID (▲-▲-▲)

## SHORT NOTE

### APPLICATION OF SPECTROPHOTOMETRY FOR ESTIMATION OF TRIAMCINOLONE ACETONIDE IN ITS DOSAGE FORMS

Triamcinolone acetonide (TCA) is an antiinflammatory glucocorticoid, chemically known as 9, fluoro-11, 12-dihydroxy-16, 17- 1-methylidene bis (oxy) pregna-1, 4-diene-3, 20-dione. It is official in B.P.'80 and U.S.P. XX/N.F. XVI.

Official methods of estimation are U.V. spectrophotometry for pure drug<sup>1</sup> and HPLC for pure drug and formulations<sup>2</sup>. Other reported procedures include Polarography<sup>3</sup>, qualitative paper chromatography<sup>4</sup>, column chromatography<sup>5</sup>, U.V. absorptiometry for estimation in body fluids<sup>6,7</sup>, HPLC<sup>8</sup>, Gas chromatography<sup>9</sup> and colorimetry using tetrazolium blue<sup>10,12</sup> and by reaction with isoniazid<sup>11</sup>.

The present communication describes a single colorimetric procedure based on quantitative colorimetric reaction of TCA with 4-amino antipyrine. The chromogenic species resulted is quantified at its absorbance maxima of 385 nm. The validity of Beer's law was ascertained by linearity of the calibration curve over the concentration range of 5 - 50 mcg/ml.

Instruments; Shimadzu UV 240 U.V./Visible recording spectrophotometer, Japan.

1. Solution of 4-amino antipyrine - 0.5% W/V in methanol containing 1 ml of hydrochloric acid per 100 ml.

Preparation of standard drug solution:—

The authenticity of a reference sample of TCA was ascertained by B.P. method. 10 mg of the drug was dissolved in methanol so as to obtain 100 ml solution containing 100 mcg/ml of TCA.

Preparation of sample solution:—

1. Ointments and creams:—

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Accurately weighed sample containing 10 mg of TCA was transferred to a separating funnel containing 100 ml of cyclohexane and 50 ml of methanol and shaken for 15 minutes. After separation of two layers the bottom layer was treated with 200 ml of water containing about 5 g. of sodium chloride and extracted with 5 X 50 ml portions of chloroform. Each chloroform layer was passed through a bed of anhydrous sodium sulphate and the combined extract was evaporated to dryness. The residue was transferred to 100 ml volumetric flask by dissolving in methanol and same solvent was used to make up the volume.

2. Sterile suspension:—

Contents of five vials were thoroughly mixed and quantity of suspension equivalent to 10mg of TCA was transferred to a 100 ml volumetric flask. About 60 ml of methanol was added to the flask and shaken vigorously for 30 minutes. The volume was adjusted with methanol and the solution was filtered through a filter paper. The filtrate after rejecting first 30 ml was used for analysis.

3. Tablets containing Triamcinolone base:—

20 tablets were accurately weighed and finely pulverised. Quantity of powder containing 9.08 mg of triamcinolone (equivalent to 10 mg of TCA) was successively extracted with 4 X 20 ml portions of methanol. Each extract was filtered through a filter paper into a 100 ml volumetric flask. Additional 10 ml of methanol were passed through the filter and the volume was made up with the same solvent.

Method of analysis:—

1,2,3, and 4 ml aliquots from the sample solutions taken in a series of 10 ml volumetric flasks

were treated with 2 ml of solution of 4-amino antipyrine and the flasks were immersed for fifteen minutes in a waterbath maintained at  $50^{\circ} \pm 20^{\circ} \text{C}$ . After cooling the volume was made up with methanol and the absorbances were recorded at 385 nm against a reagent blank. Various volumes of the standard drug solution were treated in an identical manner and a standard curve was obtained by plotting the absorbances against the known concentrations. The drug content of the sample were then established from the standard curve. The results were statistically evaluated and recovery experiments were carried out. The results are presented in Table 1.

Optimisation of the reaction conditions was effected through various preliminary experiments. It is evident from the results of the statistical analysis and the recovery studies that the suggested method is reproducible and reliable for the quantitation of TCA in its formulations. It is simple, sensitive and requires less investment as compared to the U.S.P. procedure. No interference was observed from neomycin, nystatin and gramicidin. A tablet containing triamcinolone base was successfully analysed, the drug content being computed from the molecular equivalents. The authors express their sincere thanks to Principal of Goa College of Pharmacy for providing necessary research facilities; Prof. O. S. Kamalapurkar for his helpful guidance and Cynamid (I) Ltd. for a gift of authentic drug sample.

**TABLE 1**

Sample	Labelled claim per 1ml/1g/tablet mg	Amount of drug* found by proposed method mg	Percentage recovery	Standard deviation	C.V. %
Sterile suspension	10	10.229	100.55	$\pm 0.112$	1.0990
Ointments					
O <sub>1</sub>	1	0.966	99.39	$\pm 0.0096$	0.9903
O <sub>2</sub>	1	0.972	100.66	$\pm 0.0083$	0.8484
Cream C <sub>1</sub>	1	1.003	100.55	$\pm 0.0052$	0.5199
Tablet T <sub>1</sub> **	4	3.906	97.59	$\pm 0.025$	0.636

\* Each result is a mean of four replicates.

\*\* Content of triamcinolone base.

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Pharmaceutical Research Laboratory  
Goa College of Pharmacy,  
Panaji, Goa, 403001

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E. V. Gaitonde\*  
G. J. Kamat  
\*For Reprints

## SHORT NOTE

### ANALYSIS OF A DRUG PREPARATION CONTAINING NOSCAPINE, EPHEDRINE HYDROCHLORIDE AND CHLORPHENIRAMINE MALEATE BY THIN LAYER CHROMATOGRAPHY.

Pharmaceutical preparations are the complex mixtures of several drugs each having its own effect. As far as the analysis of such preparations is concerned, interference of one drug into another is observed usually. Also the official methods which are adopted for it are lengthy, tedious and often does not give reproducible results. Therefore the aim of this part of present endeavour is to separate the components of complex drug preparation on a single chromatoplate and evaluate the components by spectrophotometric method. This chromatographic method is sensitive, accurate, fast, versatile, economical and reproducible.

Shimadzu — U V 240 / visible recording spectrophotometer.

As all the three drugs absorb light in uv range, they were quantitated by ultraviolet absorption spectrophotometry.

Noscapine in 95% ethanol exhibits an absorption maxima at 291 nm (E 1% 1 cm 92) while ephedrine hydrochloride in 0.1N hydrochloric acid exhibits an absorption maxima at 253 nm (E 1% 1 cm 8) and chlorpheniramine maleate in 0.1 N sulphuric acid exhibits an absorption maxima at 265 nm (E 1% 1 cm 212).

The label claims per capsule are

Noscapine	.....	8 mg
Ephedrine hydrochloride	.....	8 mg
Chlorpheniramine maleate	.....	2 mg

- 1) 8 mg of noscapine was dissolved in 100 ml of ethanol.
- 2) 8 mg of ephedrine hydrochloride was dissolved in 100 ml of ethanol.

- 3) 2 mg of chlorpheniramine maleate was dissolved in 100 ml of ethanol.

20 capsules were weighed and their contents were removed. The empty shells were weighed. The content was mixed. From this, content equivalent to one capsule was transferred to a 250 ml beaker. 70 ml of ethanol was added to this and shaken for 5 minutes. The solution was filtered through whatman no. 42 paper in a 100 ml volumetric flask. The residue was washed with 5 ml each of ethanol 3-4 times and the volume was made upto 100 ml with ethanol.

8 mg of noscapine, 8 mg of ephedrine hydrochloride and 2 mg of chlorpheniramine maleate were weighed accurately and dissolved in 100 ml of ethanol.

The sample of noscapine was checked for its purity by B.P. specifications while that of ephedrine hydrochloride and chlorpheniramine maleate by I.P. specifications.

The glass plates were coated with silica gel G.\* The dried plate was divided into three parts, the central one kept for blank while the remaining two for test and standard solutions each. Likewise three chromatoplates were prepared, 0.25, 0.5 and 0.75 ml of each of standard and test solution was streaked on the respective section of the plates. The plates were developed using the solvent system chloroform : benzene : n-butanol : methanol — (30 : 12 : 6 : 4). The drugs were separated at following R<sub>f</sub> values —

Noscapine	.....	0.95
Ephedrine hydrochloride	.....	0.10
Chlorpheniramine maleate	.....	0.80

The resulting band each of the above drug was scrapped out from the plate and treated in following manner —

a) The scrappings of the band corresponding to noscapine were transferred to a 250 ml beaker. 70 ml of 95% ethanol was added to it and stirred. The solution was filtered in a 100 ml volumetric flask. The residue was washed with 5 ml each of 95% ethanol 3-4 times. The washings were added to filtrate and volume was adjusted to 100 ml with 95% ethanol. This procedure was done with standard, test and also the corresponding portion of blank section.

b) The scrappings of the band corresponding to ephedrine hydrochloride were transferred to 250 ml beaker. 70 ml of 0.1 N hydrochloric acid was added to it and stirred. The solution was filtered in a 100 ml volumetric flask. The residue was washed with 5 ml each of 0.1 N hydrochloric acid 3-4 times. The washings were added to filtrate and volume was adjusted to 100 ml with 0.1N hydrochloric acid. This procedure

was done with standard, test and also the corresponding portion of blank section.

c) The scrappings of the band corresponding to chlorpheniramine maleate were transferred to a 250 ml beaker. 70 ml of 0.1 N sulphuric acid was added to it and stirred. The solution was filtered in a 100 ml volumetric flask. The residue was washed with 5 ml each of 0.1 N sulphuric acid 3-4 times. The washings were added to filtrate and volume was adjusted to 100 ml with 0.1N sulphuric acid. This procedure was done with standard, test and also the corresponding portion of blank section.

To the content of 5 capsules, 8mg of noscapine, 8 mg of ephedrine hydrochloride and 2 mg of chlorpheniramine maleate were added. From this admixture the quantity of content equivalent to 8 mg of noscapine was taken and analysed by the proposed method. The percentage recovery of the active ingredients were computed from the results obtained. Further statistical evaluation indicated the precision of the proposed method.

TABLE

Drug	Labelled content per capsule in mg.	Content per capsule by proposed method in mg.	Amount of drug recovered in mg.	% Recovery.	Standard deviation.	Coefficient of variation %
Noscapine	8	8.0502	8.1960	102.45	±0.05339	0.66513
Ephedrine hydrochloride	8	7.9788	8.1018	101.27	±0.22141	2.78641
Chlorpheniramine maleate	2	2.0101	1.9899	99.49	±0.05873	2.88303

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Phytochemistry Research Labs.  
Goa College of Pharmacy,  
Panaji, Goa-403 001.

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R. V. Gai'onde\*  
S. N. Joshi

\*For Reprints

SHORT RESEARCH COMMUNICATION

TLC - SPECTROPHOTOMETRIC ANALYSIS OF STRYCHNINE AND BRUCINE FROM THE AYURVEDIC PILLS OF NUX VOMICA

R. V. GAITONDE and SANJAY JOSHI

*Phytochemistry Lab., Goa College of Pharmacy, Panaji-Goa-403 001, India*

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**ABSTRACT:** Ayurvedic preparations claim on their label only the quantity of crude drugs and not the quantity of active ingredients present therein. So work was taken upto find the percentage of strychnine and brucine from Ayurvedic pills of Nux vomica powder by TLC spectrophotometric analysis, which study has not been reported earlier. However, the literature survey only revealed the following work.

**Literature Survey**

A. Yaneva et al<sup>1</sup> separated strychnine from elixirs by TLC using ethyl alcohol, chloroform as mobile phase, C. Muller et al<sup>2</sup> developed a gas chromatographic method for estimation of strychnine M. Chiarotti et al<sup>3</sup> developed capillary gas chromatography to estimate strychnine. A. Lawrence et al<sup>4</sup> developed HPLC to estimate strychnine. Iskander et al<sup>5</sup> developed HPLC for brucine.

**Experimental**

The label claimed per pill as,  
Nux Vomica powder — — — — 65mg.

**Preparation of Test Solution**

20 pills were weighed and powdered. Powder equivalent to the weight of 10 pills was weighed and transferred to a 250ml beaker. To this 80ml of ammoniacal chloroform was added and stirred with the help of a magnetic stirrer for about 10 minutes. The chloroform layer was removed. The residue was washed with 5ml each of chloroform 3-4 times and added to original layer. The chloroform layer was evaporated to dryness. The residue so obtained was dissolved in 50ml of chloroform and trans-

ferred to a 100ml volumetric flask. The volume was then made upto 100ml with chloroform.

**Preparation of standard solution**

7 mg of drug strychnine and 8 mg of brucine were weighed accurately and dissolved in about 50ml of chloroform. This solution was then transferred into a 100ml volumetric flask and the volume was adjusted with chloroform.

**Separation and Quantitation of Alkaloids:**

The chromatoplates of 20×20 cm size were prepared with silica gel G<sup>6</sup> of thickness 500 and then activated at 105-110° c for 1 hr. The dried plate was divided into three parts, the central one kept for blank while the remaining for test and standard solutions each. Likewise three chromatoplates were streaked using 0.25, 0.50, and 0.75ml of test and standard solution. The plates were developed with the mobile phase, Ethyl-acetate: Chloroform: Ammonia solution (40:8:2) in an unsaturated chamber and run to a distance of 13 cm. Visualisation was done by spraying the plate with acidified iodoplatinate reagent. For the purpose of scrapping reference plate with the same conditions was prepared and Visualised by above method and then knowing the R<sub>f</sub> value,

scrapping was done. The Rf values for strychnine and brucine were 0.72 and 0.92 respectively. The corresponding bands were scrapped out and then analysed by Shimadzu-UV 240/visible spectrophotometer at 251nm for strychnine and 267nm for brucine in ethyl alcohol.

### Recovery Experiment

To the powder equivalent to weight of 10 pills, 10mg each of strychnine and brucine were added. From this admixture a quantity of powder equivalent to weight of 10 pills was analysed by the proposed method. The percentage recovery for both the alkaloids was obtained. Further statistical evaluation indicated the precision of the proposed method.

### Results and conclusion

The samples of Nux Vomica powder from two different companies were analysed by the proposed method for the content of strychnine and brucine. The amount found is as follows.

Sample No.	Strychnine %	Brucine %
I	1.2405	1.3886
II	1.1422	1.2232

### Acknowledgement

The authors are thankful to Prof. J. Emmanuel, Ag. Principal, Goa College of Pharmacy, Panaji for providing the necessary facilities for this research work.

Drug	Content per pill by the proposed method (mg)	Amount of drug added (mg)	Amount of drug recovered (mg)	Percentages recovery	Standard deviation	Coefficient of variation
Strychnine	0.7550	10	9.820	98.20	± 0.1979	2.6627
Brucine	0.8794	10	10.011	100.11	± 0.2052	2.3836

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# DETERMINATION OF BROMHEXINE HCL IN ITS FORMULATIONS BY COLORIMETRY

R. V. Gaitonde & Ganadhish J. Kamat  
Goa College of Pharmacy, Panaji, Goa-403 001.

## Abstract :

Bromhexine hydrochloride a primary aromatic amine was coupled with thymol after diazotizing it with sodium nitrite and hydrochloric acid. Quantitation was done by absorptiometric measurement of the orange dye at 450 nm which is the wavelength of its maximum absorbance. Validity of Beer's Law over a concentration range of 1-9 mcg/ml. made it possible to analyse the formulations of the drug by the proposed method after its standardisation. The results were statistically verified.

Bromhexine hydrochloride (BXH), chemically known as 2-amino-3,5-dibromo-N-cyclohexyl-N-methyl-benzene methanamine monohydrochloride is a potent mucolytic expectorant, official in B.P. 80<sup>1</sup>. Official method is non-aqueous titration for the pure drug and U.V. spectrophotometry for tablets. Other analytical methods include U.V. spectrophotometry<sup>2-4</sup>, gravimetry,<sup>5</sup> titrimetry<sup>5,6</sup>, GLC<sup>7,9</sup>, HPLC<sup>10,11</sup>. Bowtle et.al<sup>12</sup> described a colorimetric method based on extraction of ion pair complex with bromocresol purple. Maria Ines et.al<sup>13</sup> and Shingabl et. al<sup>14</sup> employed Bratton Marshall reagent in its estimation.

The proposed method is based on coupling of diazonium salt of the drug with thymol in alkaline medium. The orange chromophore formed is stable for more than six hours and shows peak absorbance at 450 nm. Compliance with Beer's law is obvious from the linearity of plot of absorbance v/s concentration over the range of 1-9 mcg/ml.

## Experimental:

Instruments:— 1) SHIMADZU UV 240, U.V./Visible recording spectrophotometer, Japan.

2) CZ Spekol spectrophotometer.

## Reagents:

1. Solution of sodium nitrite (G.R.)—A 2% W/V solution in distilled water.

2. Solution of hydrochloric acid (Analar)—A 2% V/V solution of hydrochloric acid (36%) in distilled water.

3. Solution of ammonium sulphamate (BDH)—A 5% W/V solution in distilled water.

4. Solution of thymol—0.1% W/v solution in methanol (Analar).

5. Solution of sodium hydroxide (G.R.)—1% W/V solution in distilled water.

A reference sample of BXH was analysed as per B.P. 80 to check its purity. Accurately weighed 20 mg of the drug were dissolved in distilled water to 100 ml of solution. 25 ml of this solution after mixing were diluted to 100 ml with same solvent to obtain a working standard containing 50 mcg/ml of BXH.

## Preparation of Standard Drug Solution :

1. *Tablets*: 20 tablets were accurately weighed and finely powdered. Powder equivalent to 20 mg of the drug was extracted with four 20 ml portions of distilled water, passing each extract through a filter paper into a 100 ml volumetric flask. 10 ml of water was passed through the filter and final volume was made up with distilled water. 25 ml of this solution was diluted to 100 ml with distilled water.

2. *Liquid Formulations*: Amount of formulation equivalent to 20 mg of BXH was transferred to a separating funnel containing 5 ml of 1N sodium hydroxide solution and 25 ml of water. The solution was extracted with four 25 ml portions of chloroform. The combined chloroform extract was evaporated to dryness, residue dissolved in 25 ml of 0.1N hydrochloric acid and diluted to 100 ml with distilled water and mixed. 25 ml of this solution was further diluted with distilled water to 100 ml to obtain the sample solution. Assay Procedure:

1, 2 and 3 ml aliquots of sample solutions were transferred to different 25 ml volumetric flasks followed in



# Analysis of Drug Preparation Containing Chlorpropamide and Phenformin Hydrochloride by Thin-Layer Chromatography

R.V. GAITONDE, U. RIVANKAR

Phytochemistry Laboratory, Goa College of Pharmacy, Panjim - Goa, 403001 India

## KLORPROPAMİD VE FENFORMİN-HCL İÇEREN TABLETLERİN İNCE TABAKA KROMATOĞRAFİSİ YÖNTEMİYLE ANALİZİ

### Özet

Eczacılık preparatlarının içerdikleri bileşenlerin belirleniminde genellikle farmakopilere uygun yöntemler kullanılır. Ancak bu yöntemlerin bir bölümü oldukça pahalı gereçleri veya uzun süren işlemleri gerektirir. Bu nedenle, klorpropamid ile fenformin-HCl içeren ve antidiabetik olarak kullanılan tabletlerin analizi için bir yöntem geliştirdik. Bu yöntemde, önce etkinleştirilmiş Silikajel G tabakaları ve metanol : amonyak : su ( 49:49:2) mobil fazı kullanılarak bileşenler birbirlerinden ayrılmakta, daha sonra Shimadzu UV 240 spektrofotometresiyle miktarları tesbit edilmektedir. Yapılan literatür taramasında benzer bir yöntemle rastlanmamış olup, farmasötik preparatlarda hızlı, ucuz ve basit bir şekilde klorpropamid ve fenformin belirlenimi için önerilmektedir.

### Summary

The pharmaceutical preparations are usually analyzed by pharmacopial methods for their individual components. This involves either sophisticated instruments or time consuming factors. Therefore a method was developed to analyze a pharmaceutical antidiabetic preparation in the form of a tablet containing chlorpropamide and phenformin hydrochloride. This involves, first, separation of the individual components by a simple thin-layer chromatography (TLC), and then estimating the same by spectrophotometric method (Shimadzu UV 240). Literature survey does not reveal any work on such above mentioned formulation. Therefore, the devised method was found simple, economical and time saving.

Keywords: Chlorpropamide - Phenformin HCl - TLC analysis - Spectrophotometric method

## INTRODUCTION

*Mill and Chamberlain* (1) determined phenformine in human body fluids by using *HPLC*. *Allesandro et al* (2) have estimated biguanides by complexometric titration. Their determination was by formation of Cu complexes from cuprammonium or Fehling's solution. *Wickramsingha and Shaws* (3) estimated phenformine and other biguanides by using gas chromatography. *Joshi* (4) determined chlorpropamide and its metabolites in plasma by using *HPLC*. *Takla and Joshi* (5) identified, assayed and determined the purity of chlorpropamide, glibenclamide and tolbutamide by *TLC*. They have used cyclohexane : chloroform : acetic acid : ethanol (10/1/2/1). *Zecca and Colombo* (6) estimated glibenclamide, chlorpropamide and tolbutamide in plasma by *HPLC* with *UV* detection.

## MATERIAL AND METHODS

- The label claims per tablet as : chlorpropamide 50 mg ; phenformin 25 mg.

### *Preparation of test solution*

Five tablets were triturated in a glass mortar, and then the powder equivalent to two tablets was extracted in 70 mL ethanol. The solution was filtered through Whatman no. 42 paper in a 100 mL volumetric flask. The residue was washed with 5 mL each of ethanol 4 times and then added to the original to make up the volume.

### *Preparation of standard solution*

100 mg of chlorpropamide and 50 mg of phenformin were weighed accurately and dissolved in 100 mL of ethanol. The above samples were checked for its purity by IP specifications (Figures 1,2).

### *Separation and quantitation*

The chromoplates of 20x20 cm size were prepared with silica gel G of thickness 500  $\mu\text{m}$  and then activated at 100 -105°C for one hour. Each three activated chromoplates were taken and streaked using 1, 1.25 and 1.5 mL of test and standard solution. The plates were developed in a saturated developing chamber using methanol : water : ammonia solution (49:49:2) as a mobile phase. The plates were run to a 12 cm which took 25 minutes. Visualization was done by spraying the plates with 2% potassium permanganate reagent in water. For the purpose of scrapping a reference plate under the same conditions was prepared and then knowing the *R<sub>f</sub>* values scrapping was done.

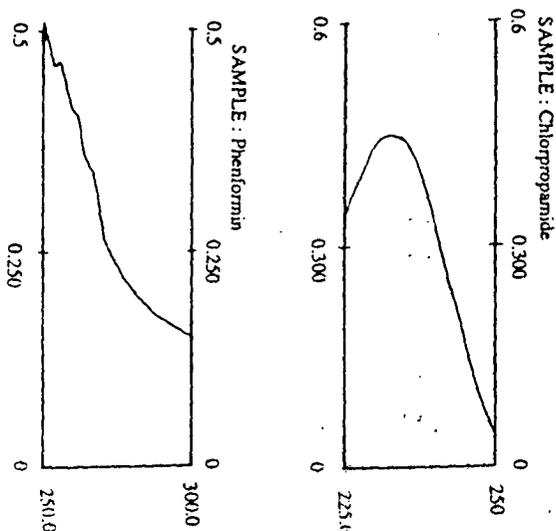


Figure 1. Spectra of chlorpropamide and phenformin.

Table 1. TLC - data of the analysis of chlorpropamide and phenformin HCl containing tablets.

Drug	Content/tab. by proposed method.	Drug added (mg)	Drug recovered (mg)	Recovery (%)	S.D.	C.V.
<i>Chlorpropamide</i>	54.08	100	102.6	102	0.3836	0.7080
<i>Phenformin-HCl</i>	27.42	50	51.9	103	0.3919	1.4453

The drugs were separated at following Rf values:

Chlorpropamide 0.85, Phenformin 0.25.

The resulting band each of above test and standard solution was scrapped out and treated in the following manner:

a) Scrapping corresponding to ref. chlorpropamide spot was extracted in 100 ml, 0.01N HCl and then analyzed by Shimadzu UV 240 / Visible spectrophotometer at 232 nm (E 1 % 1 cm 600).

b) Scrapping corresponding to ref. phenformin spot was extracted in 5 mL of 0.1N sulfuric acid and then analyzed by Shimadzu UV 240/Visible spectrophotometer at 251 nm (E 1 % 1 cm 11).

## RESULTS AND DISCUSSION

The content of two tablets 100 mg chlorpropamide and 50 mg phenformin were added. From this mixture the quantity of content equivalent to 100 mg of chlorpropamide was taken and analyzed by proposed method (Table 1). The percentage recovery of the active ingredients was computed from the results obtained. Further statistical evaluation indicates the precision of the proposed method.

### Acknowledgement

The authors are very much thankful to *Prof. J. Emmanuel*, Principal, Goa College of Pharmacy for providing necessary facilities for the research work.

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Reprints request to :

Prof. R.V. Gaitonde  
Goa College of Pharmacy  
Panjim - Goa, 403001  
India

# TLC - Spectrophotometric Determination of Total Sennoside from Marketed Galenical Preparation

R.V.GAITONDE, ULHAS BHAT

Phytochemistry Laboratory, Goa College of Pharmacy Panaji, Goa - 403 001, India.

## GALENİK PREPARATLARDAKİ TOTAL SENNOZİD DÜZEYLERİNİN İNCE TABAKA KROMATOĞRAFİSİ VE SPEKTROFOTOMETRİ İLE BELİRTİMİ

### Özet

Piyasada satılan galenik preparatlardaki terapötik etkiye sahip aktif madde içeriğinin miktarı belirtilmemektedir. Sonamukhi (*Cassia angustifolia*) ekstraktı içeren böyle bir preparatın içerdiği total sennosid miktarı açısından incelendi. Bu araştırma, böyle bir preparat içerisindeki etken madde miktarının İTK-spektrofotometrik yöntemle tesbit edilebileceğini göstermektedir.

Yapılan literatür araştırmasında benzer bir çalışmaya rastlamadık.

### Summary

Galenical preparation sold in the market do not mention the amount of active ingredient having therapeutic effect. Such one preparation containing extract of Sonamukhi (*Cassia angustifolia*) was analysed for total sennoside content. The present work deals with finding out the actual amount of the active ingredient present there in, by TLC-spectrophotometric method.

Literature survey does not reveal any work on such a product.

**Keywords:** Galenical preparations - Active ingredient - Sennoside - TLC-Spectrophotometric method

### Literature Survey

Lane (1) determined sennoside A and its derivatives in biological tissues by fluorometry. The fluorescence intensity was measured at 510 nm.

Method Brendel and Schneider (2) determined sennosides in senna pods and leaves spectrophotometrically. Wahbi et al (3) determined sennosides from senna powder by a colorimetric method. The yellow colour was measured at 390 nm.

Hayashi et al (4) determined sennosides in senna powder by HPLC.

## Experimental

The label claimed on the galenical preparation, each 30 mL contains : extract of Sonamukhi - 1.15 gm.

### Preparation of Test Solution

20 mL of galenical solution was diluted with hot distilled water and volume was made upto 100 mL.

### Standard Solution

100 mg of the powder of calcium sennoside ( 20 % ) was digested with 70 mL of hot water, filtered and the volume was made up to 100 mL.

### Separation and Quantitation of Sennoside

Chromoplates of 20 x 20 cm size were prepared with silica gel G of thickness 500  $\mu$ m and then activated at 105°C - 110°C for one hour. Each three activated chromoplates were taken and streaked using 0.25, 0.50 and 0.75 mL of test and standard solution. The plates were developed in a saturated developing chamber using benzene: acetic acid (70:30) as a mobile phase. The plates were run to a 10 cm which took 30 minutes. Visualization was done by spraying with strong ammonia solution. For the purpose of scrapping a reference plate under the same conditions was prepared and then knowing the Rf value scrapping was done. The Rf value for sennoside was 0.9. The corresponding band was scraped out and analysed by Shimadzu UV 240 visible spectrophotometer at 270 nm in 5% bicarbonate solution (5).

### Recovery Experiment

To 20 mL of the galenical solution 50 mg of powder of calcium sennoside (equivalent to 10 mg) was added. From this admixture the quantity of galenical 13.18 mL (equivalent to 19.32 mg of sennoside) was removed as per the results of preanalysed sample. The solution was then diluted with hot water and analysed by the proposed method. The percentage recovery was computed from the results obtained. Further, statistical evaluation indicated the precision of the proposed method.

Drug	Sennoside obtained 20 mL	Amt. of drug added in mgs.	Amt. of drug recovered in percentage	Standard deviation (S)	Co-efficient of variation (%)
Sennoside	29.119 mg	10	98%	$\pm 0.0099$	1.02258

### Acknowledgement

The authors were thankful to Prof. *J. Emmeanuel*, Principal GOA College of Pharmacy, *Panaji*, for providing the necessary facilities for this research work.

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Reprints request to :

R.V. Gaitonde  
Goa College of Pharmacy  
Panaji, GOA - 403 001  
India

# ANALYSIS OF A DRUG PREPARATION CONTAINING EPHEDRINE HYDROCHLORIDE, THEOPHYLLINE, CHLORPHENIRAMINE MALEATE AND DIAZEPAM BY THIN LAYER CHROMATOGRAPHY.

R. V. Gaitonde\* and Umesh Rivankar

(Received 22 October 86)

## ABSTRACT

Marketed samples are usually analysed by official methods of Pharmacopoeia which are time consuming and tedious. Hence analytical study was carried out to evaluate a marketed sample containing Ephedrine, theophylline, chlorpheniramine maleate, Diazepam as their individual contents using thin layer chromatography and spectroscopy as analytical tool.

## METHODS

### Experimental :

Label claims, per tablet as

Ephedrine Hydrochloride	.....	20 mg
Theophylline	.....	100 mg
Chlorpheniramine maleate	.....	3 mg
Diazepam	.....	2.5 mg

### Preparation of Test Solution :

Five tablets were triturated in a glass mortar and then powder content equivalent to two tablets were extracted in 70 ml ethanol. The solution was filtered through whatman no : 42 paper in a 100 ml volume-

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Phytochemistry Laboratory, Goa College of Pharmacy,  
Panaji -- Goa, 403 001, INDIA.

\* For reprints

INDIAN DRUGS, 24 (10)

tric flask. The residue was washed with 5 ml each of ethanol 4 times and the washings added to the original extract and the volume, made up to 100 ml with ethanol.

### Preparation of Standard Solution :

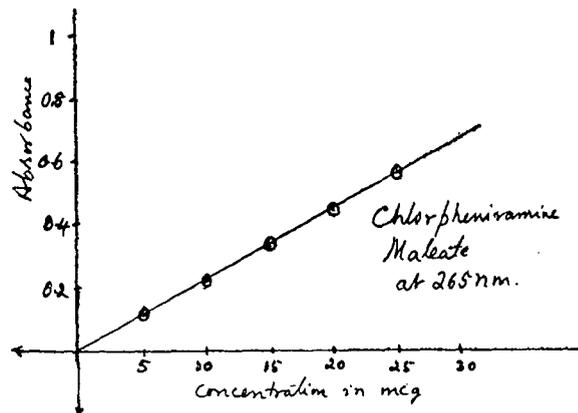
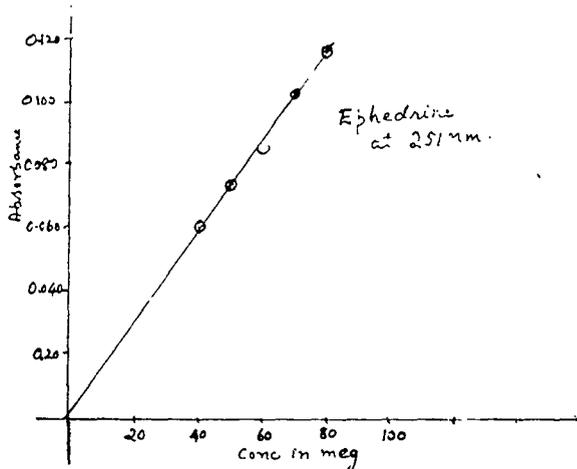
40 mg Ephedrine Hydrochloride, 200 mg Theophylline, 6 mg Chlorpheniramine Maleate and 5 mg Diazepam were weighed accurately and dissolved in 100 ml ethanol.

The above samples were checked for their purity by I.P. specifications.

It was found that the absorbance vs concentration was linear for Ephedrine from 40 mcg to 80 mcg at 251 nm as in **Graph (1)** and for Theophylline from 5 mcg to 25 mcg at 270 nm as in **Graph (2)**. It was confirmed for Chlorpheniramine Maleate from 5 mcg to 25 mcg at 265 nm as in **Graph (3)** and for Diazepam from 1 to 5 mcg at 241 nm as in **Graph (4)**.

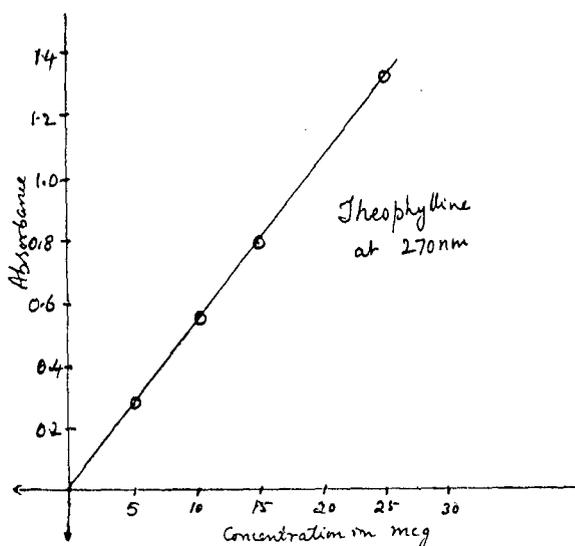
### Separation and Quantitation :

The chromoplates of 20 x 20 cm size were prepared with silica gel G of thickness 500 u and then activated at 105 — 110°C for 1 hour. Each three chromoplates were streaked using 1, 1.25 and 1.5 ml of Test and Standard Solutions. The plates were developed then by using the solvent system :- Methanol : Chloroform : Strong Ammonia solution (50 : 15 : 1.5).

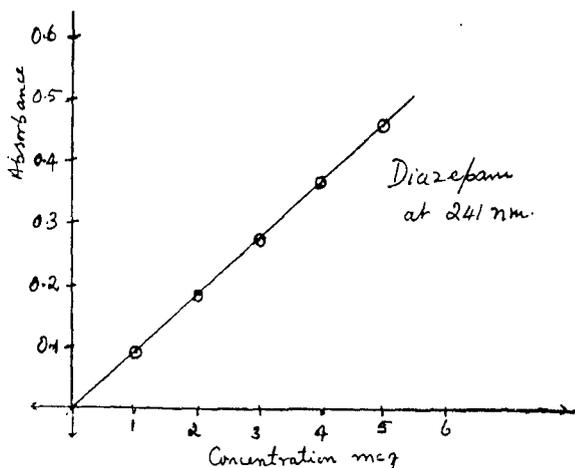


Visualisation was done by spraying the plate with 2% potassium permanganate reagent in water. For the purpose of scraping, reference plate under the same conditions was prepared and then knowing the Rf value scraping was done. The drugs were separated at the following Rf values.

Ephedrine Hydrochloride	.....	0.5
Theophylline	.....	0.87
Chlorpheniramine Maleate	.....	0.75
Diazepam	.....	0.95



The resulting band of each of the above test and standard solution was scraped out and treated in the following manner.



a) Scraping corresponding to Ref. ephedrine hydrochloride spot, was extracted in 5 ml 0.1 N  $H_2SO_4$  and absorption measured on Shimadzu UV240/visible Spectrophotometer at 251 nm. (E 1% 1 cm = 9).

b) Scraping corresponding to Ref. Theophylline Spot, was extracted in 20 ml 0.1 N HCl. From this 1 ml was taken and further diluted to 10 ml with 0.1 N HCl. The absorption of this was then measured on Shimadzu UV<sub>241</sub>/visible Spectrophotometer at 270 nm (E 1% 1 cm = 530).

c) Scraping corresponding to reference Chlorpheniramine Maleate Spot, was extracted in 5 ml of 0.1

**TABLE**

Drug	Content/ tab by proposed methods in mgs.	Amount of drug added in mgs.	Amount of drug recovered	Percentage recovery	Std. deviation	Coefficient of variation
Ephedrine Hydrochloride	17.2	40	38.41	96%	0.2880	1.6808
Theophylline	95.9	200	194.45	97.22%	0.8000	0.8350
CPM	2.65	6	5.56	5.56%	0.7190	2.7051
Diazepam	2.2	5	4.62	92.4%	0.0676	3.0459

NH<sub>4</sub>SO<sub>4</sub>. The absorption of this solution was measured on Shimadzu UV<sub>vis</sub>/visible Spectrophotometer at 265 nm. (E 1% 1 cm = 240).

d) Scraping corresponding to reference Diazepam Spot, was extracted in 20 ml of 0.1 N Sulphuric acid. The absorption was then measured on Shimadzu UV<sub>vis</sub>/visible Spectrophotometer at 241 nm (E 1% 1 cm = 1402).

**Recovery :**

To the content of 2 tablets, 40 mg of Ephedrine Hydrochloride, 200 mg of Theophylline, 6 mg of Chlorpheniramine Maleate and 5 mg of Diazepam were added. From this mixture the quantity of content equivalent to 200 mg theophylline was taken and analysed by proposed method. The percentage reco-

very of the active ingredients were computed from the results obtained. Further statistical analysis indicated the precision of the proposed method.

**ACKNOWLEDGEMENT**

The authors are very much thankful to Prof. J. Emmanuel, Principal, Goa College of Pharmacy for providing necessary facilities for this research work.

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