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B.Sc. BOTANY

THIRD YEAR

PAPER - IX : MEDICINAL BOTANY

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Unit I

- History of medicinal plants.
- A general account on different surveys of different systems of medicines.
- Indian systems of medicines- Siddha and Ayurvedha systems.

Unit II

- Classification of crude drugs.
- Morphological and histological studies, chemical constituents, therapeutic and other pharmaceutical uses of roots (colchicum and Rauwol fia).
- Drugs form bark (Cinchona).
- Drugs from stem of wood (Ephedra).

Unit III

- Drugs from leaves (Adathoda,Eucalyptus, Ocimum),
- Drugs from flower (Eugenia).
- Drugs from fruits and seeds (wood apple, Gooseberry and poppy seeds). Under ground stem (Ginger,Curcuma).

Unit IV

- A detailed account of the following:
- Drugs acting on the 'central nervous system,
- Drugs used in disorders of gastrointestinal tract,
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- A short account on ethanobotany.
- Cultivation of medicinal plants in India.
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- Plant tissue culture as source of biomedicine.
- Drug adulteration.
- Methods of drug evaluation.

SIDDHA

INTRODUCTION

Medicine is not merely a science but an art as well. The science of medicine is of fundamental importance to man well being and survival. The Siddha system of medicine is the oldest and was derived from the vegetable kingdom. There are two ancient systems of medicine in India. The siddha which flourished in the south and Ayurveda which was prevalent in the north. These practices deal not merely with the body of man but also with the inner soul. The art of medicine is based on truth and as such it is a divine art not to be adulterated for the base purposes of money.

SIDDHA

The word siddha comes from siddhi which means an object to be attained or perfection of heavenly bliss. Siddhi generally refers to the Ashtama siddh ie, the eight supernatural powers. These who attained of achieved these powers are known as the siddhars.

The siddhars were a class of popular writers in Tamil in all branches of knowledge and many of their works were written in what is called High Tamil. The poetry, in which medical and other scientific tracts have been expressed, is much admired by specialists in that field. The siddhars were also great scientists. They were men of high culture, intellectual and spiritual faculties combined with supernatural powers. Some of the siddhars like Bogars visited Arabia, Persia, turkey, china and other places where they propagated the siddha system of medicine.

The three systems that are in practice in India are Ayurveda, siddha an unani, all of which are based on humoural pathology of in other words, on the same physiological doctrine that air, bile and phlegm are the three supports of the body. They all advocate that, without these three humours, the individual cannot exist and that if these humours are not in proper balance diseases of death will be the result.

FUNDAMENTAL PRINCIPLES OF SIDDHA:

Nature is man and man is nature and therefore both are essentially one man is said to the microcosm and the Universe is Macrocosm, because hat exists in the universe exists in man. Man is nothing but the universe in miniature containing the five elements and the various principles which constitute the mineral vegetable and the animal kingdoms.

The universe consists of two essential entities-matter and energy-which the siddhars call Siva and sakthi. The two co-exist and are inseparable. The universe consists of five elements which should not be confused with the

elements of modern chemistry. They are primordial elements (Bhootas). They are Munn (solid), neer (fluid), thee (radiamce), vayu (gas) and Aakasam (ether). All created of evolved matter in the world, whether it is animal, vegetable of mineral, falls under these categories. The human anatomy and physiology, the causative factor of diseases, the materials for the treatment and cure of diseases, the food for sustenance all fall within the five elemental categories.

BASIS OF TREATMENT:

The three physical elements of the external world ie, air, heat and water form the three fundamental principles on which the constitution of the human being has been based the three elements are known as "humors" as they enter the body. They are called tridosha. These three humors viz wind, bile, and phlegm represent respectively the air, fire and water of the five elements which form the connection link between microcosm of man and macrocosm of the world. The three humors maintain the human body through their combined functioning. When in imbalance they bring about diseases. The normal order of vatha, pitta and kappa is in the proportion of 1:1/2:1/4 of 4:2:1 respectively.

If all the factors work properly, the body will be healthy. Imbalance due to astral influences, poisonous substances and psychological and spiritual factors may also be important in causing imbalance.

1. Classification according to the variations in three humors.
2. Clinical signs
3. cause
4. The disease caused by worms, parasites and microbes.
5. Varma and Accident
6. Parts affected
7. Inherited and
8. Psychiatric illnesses.

Medicines are prescribed to set right the imbalance in the life factors either by addition, reduction of neutralisation, since all matter (herbs, minerals and metals) contain the five elements and hence the three factors. The presence of a particular factor in substances is found by the taste of the latter. The five elements in different combinations form six tastes.

DIAGNOSIS:

The words noai nadal, noai mudhal nadal indicate the approach to the process of diagnosis noai nadal means the approach to the disease. Noai nudhal nadal denotes determination of the etiology of the disease. to diagnose, the

physician investigates the cause of the disease, the signs and symptoms, complicated if any and pathological tissue (dhatu) changes. The siddhars look at a conclusion regarding the condition of diagnosis of the case. This conclusion is an essential prerequisite for treatment.

Diseases are diagnosed mainly with the help of signs and symptoms. In addition there are eight other important factors which help in finding out the disease and imbalanced life factors. They are rules (nadi), touch (sparism), tongue (naa), colour (niram), speech (mozhi), eyes (vizhi), faeces (malam) and urine (moothiram).

The five elements of the body and their life factors vata, pilta and kapha. Vata consists of Akash and vayu. Pilta consists of thee and kappa consists of prithir and Aapa.

In scientific parlance, vata comprehends all the phenomena which come under the function of the central and sympathetic nervous systems. Pilta consists of the function of thermogenesis and heat production. Metabolism within the limits, the process of digestion, colouration of blood, excretion and secretion. Kapha looks after the regulation of the heart and the formation of various glands and structures. These eight factors are widely described by the siddhars who classified the diseaseses into 4448 varieties. Etiology signs and symptoms and treatment were explained for all the varieties by different siddhars.

PULSE RECORDING:

The science of pulse is peculiar to the siddha system of medicine traditionally this science of pulse was taught by the guru to his disciples. Diagnosis of disease by the pulsle requires great skill and experience. According to he siddhars, the pulse is the manifestation of prana in living beings. Prana being the cosmic energy responsible for the evolution of the universe. It penetrates surrounds and seeps through everything.

SIDDHA PHYSIOLOGY

The physiology in the siddha system involves 96 basic factors, seven body factors, 14 reflexes, three malas (water), and 4 body fires and important features.

MATERIA MEDICA

The materia medica consists of herbs, minerals and animal products. Innumerable varieties of herbs are mentioned in siddha literature. Many of these were described in a manner very difficult to understand. The siddhars dealt with 11 metals, 64 pashanam (mercurial, no-mercuriae) and animal products in preparing medicines.

There are 64 types of medicines, of these, 32 varieties are internal medicines and other 32 are external. Some varieties of internal medicines once prepared can be used for many years. They have a long life time and their potency will not be lost.

The siddhars were the pioneers in the use of metals and minerals in the treatment of diseases. There are a number of pharmaceutical preparations common to both siddha and Ayuveda. The common preparations are Bhasma (calcined metals and minerals), churna (powders), kashaya (decoctions), Lehya (Confectins), Ghrita (gheepreparations) and Taila (oil preparations). The preparations in which the siddhars specialized are chunmna (metallic preparations which become alkaline), mezhuai (waxy preparations) kattu (preparations which are impervious the water and flame).

For a medicine to be effective, the inorganic substances have to be brought to their atomic form. The siddhars developed the knowledge of bringing inorganic substances into atomic and into ionic form which can be easily absorbed in the system when ground with herbal juices and put in the fire with a calculated number of cowdung cakes.

Lakes of formulations are available in siddha literatures. Though a few are printed, many are still in manuscripts and palm leaves.

SIDDHA CHEMISTRY

The 'siddhars' knowledge of Iatro-chemistry, minerals, metals, and plants were stupendous. This was successfully used by them from time immemorial processes like calcinations of mercury minerals and metals and the preparation of a super salt known as muppa-animated mercury pills with high potency possessing marvelous properties of transmuting metals and capable rejuvenating the entire human system bear ample testimony to the fact that, even in the remote past when knowledge in chemical technology was not fully developed, the siddhars had an unparallele & knowledge of medicine. The process of minerals and metals are special features of siddha system of medicine and are not known to other medical systems, in India of other countries.

The siddha system included not only medicine and alchemy but also yoga and philosophy. Yoga literally means union. It is the means by which is obtained omniscience and the power of achieving and controlling mighty things. It is an applied science, a systemized collection of laws applied to bring about a definite end. Siddha science acknowledges 64 kinds of yoga of yoga. There an 8 elements in yoga-eyama, niyama, as a pranayama, prathyagara, tharani, thiyc nam and Samadhi. It is said by the siddhars that there is no yoga without concentration of fixedness of mind. There are no miraculous powers

without rousing the kundalini. There is no wisdom without mind, there is no body without repression of respiration.

The siddha science of breath is known as vasi (the practice of correct breathing). There are different phase's kin sciences of breath. Physical mental, and spiritual. The kind of controlled breathing is the scientific method of charging one's self with vitality and personal magnetism and it is known to the ancients as pranayama poorakam (in spiration), rechagam (expiration) and kumbagam (suppression) are the three inetrtable steps in pranayamam.

Siddha science also tells it that man generally takes 15 breaths a minute and thus makes 21,600 breaths a day and at this rate he can live fork a period of at least 120 years.

KAYA KALPA

Besides the treatment by medicine there exist siddha works in Tamil on alchemy of kaya kalpa. As some of the alchemical processes leading to kaya kalpa treatments were dangerous in their administration the siddhara did not want to teach them to everyone. Although the siddha system might have evolved in Tamil Nadu at an early period, there is reason to believe that it spread to northern parts of India and is known as Tantric science.

In olden days, the siddhars devoted mole time in finding out suitable remedies rather than describing the causes of disease in detail. The causes of a disease in detail. The scope of kaya kalpa treatment is two fold, one to cure diseases and the other to prolong lifespan. The kalpa durgs served as a constructive medicine too.

Kalpa treatment is a weapon, preventive as well as constructive; the methods prescribed in siddha medical science in the treatment of kaya kalpa are as follows:

1. Preservation of vital energy of the body by diverting the internal secretions to the circulation of blood by control of breathing through yoga.
2. Conservation of sperm by using it for regeneration.
3. Use of universal salt such as Muppu prepared by certain siddhic process for rejuvenation.
4. Use of calcined powders prepared from metal and minerals such as Mercury, Sulphur, Mica, Gold, Copper, Iron etc.,
5. Use of durgs prepared from certain rare Indian herbs.

Many rules and regulations were adopted by siddhars while consuming kaya kalpa durgs. Some other general methods like cleansing of throat, enema, and laxation and oil baths were also detailed.

VARMA TREATMENT

Varma is a separate science prescribed by the siddhars. According to the varma texts, like "Odi murivu sari nool", there are 108 varma points in our body. A varma point is a place where the life force is acting. If it is hurt in a particular manner and with force, signs and symptoms develop according to the site of the point. If these signs and symptoms are not set aright within the stipulated period, death will occur. So these are emergenices which can be called orthspaedic emergencies according to recent medical science- specific physiotherapy was indicated for each type of varma. In addition internal medicines were also indicated.

Varma science described the various kinds of fractures which occur in the body and their cures. This science seems to be the basis for the different types of martial arts like Kalari, Judo and Karate.

APPLICATION

Siddha medicinal science has a wide range of application in medical and non-medical fields.

1. To preserve ecological balance and retain green cover of earth, herbs play a very major role. Social forestry needs to be based on medicinal value of the plants.
2. For water treatment: The modern methods of purification of water have drastically failed to provide safe potable drinking water for the masses. Herbal medicines like cleaning nut, stem, stem of emblica officianals, Indian sarasapilla are under trial for better water treatment.
3. Fire: when herbs, twigs, and roots are used to kindle fires, the environment is purified by eliminating the germs.
4. Trees like neem, vilva, pungam purify the air. Ruta graveolence (sathappu) prevents radiation hazards.
5. In the field of civil engineering, siddhas concepts of vasthu purusha is widely accepted because it is scientific.
6. Bio-pesticieds and the fertilizers using herbs have made agriculture sustainable.
7. In veterinary medicine, a wide range of herbal products are already in the market.
8. In astrology, the relationship between the planets and the human body as mentioned in siddha science is fascinating.

CONCLUSION

The paramount aim and object of siddha science is to assure the full span of 100 years of healthy life to enable man acquires knowledge, cultivated good character and conduct with which they could enjoy their legitimated worldly pleasures and ultimately attain salvation.

CULTIVATION OF LDISCOREA FLORIBUNDA

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CULLLTIVATION KOF DIOSCOREA FLORIBUNDA

INTRODUCTION

Plants of the genus Dioscorea, commonly called medicinal yams are perennial climbing herbs with tubers of rhizomes. Approximately 600 species have been reported to occur throughout the world mostly in tropical and subtropical regions land, to a limited extent, in temperate regions also of these, 15 species are known to contain steroidal sapogenins chiefly diosgenun. Out of the various species tested Diascorea composita, and Dioscorea floribunda

found growing wild in central America and D deltordea found in the north-western Himalayas, are the main species from which diosgenin is extracted commercially. All the three species are dioecious.

ULTIVATION PRACTICES

MULTIPLICATION

Crop can be raised from seeds as well as single node leaf cutting of tuber pieces.

COMMERCIAL CROP FROM SEEDS

Dioscorea is a dioecious plant observation indicate that female plants will not set seed unless the male plants are in close physical proximity. Female plants set apart from the male plants by as close as 30 cm distance will not set seeds unless the male spikes of flowers actually inter-twine with the female flowers. Once this contact is made there is excellent seed set under Bangalore conditions. The flowering starts from September onwards and the seeds ripen by late January. The seed pods are shade dried till they dehisce.

For raising a commercial crop from seed, fresh seeds should be sown in plastic bags of convenient size (7-5cm wide and 15 cm long must commonly used size). Drainage holes should be provided at the bottom of the bags.

The planting mixture consists of equal parts of soil, sand and farmyard manure. The mixture should be sterilized. At least seeds should be sown in.

This method is not being used commercially as the progeny is variable and growth is slow.

SINGLE LEAF NODE CUTTINGS PROGRATION

The multiplication rate in D. floribunda through tuber cuttings averages about 5-6 times in one year. For faster multiplication, plants can be raised from single node leaf cuttings. The cutting consists of a single leaf with petiole and about 0.8 cm of the stem. The cutting should be taken in the early part of the year from non-flowering plants. The mother plants should be vigorously growing. The stem end of the leaf cutting should be dipped in 1 ppm solution of 2,4 – D of quick dipped in 5000 ppm of IBA solution. The cuttings are planted in the mist chamber in sand beds. The intermittent mist is for 3-5 seconds at three minutes interval depending on the humidity and temperature. The callous is formed in about 4 week's time. The shoot and the roots develop subsequently. After about 8-10 weeks in each plastic bag at a depth of 0.6 to 1.2 cm during February. Nursery should be located in the shade. If available 1.2cm layer of vermiculture to retain moisture can be used on the top. Watering should be done with a fine spray can, so that the seeds are not disturbed. The germination starts after about 15-20 days of planting upon the

prevailing temperature and is complete in 4-5 weeks. The seedlings should be provided with supports with thin sticks some similar material.

The best time for transplanting the field is when the rains start. This is usually in July in Bangalore. The whole plastic bag with the bottom and sides cut open with a razor blade should be transplanted in the field, at a spacing of 45 cm *30 cm. .The seedlings should be irrigated frequently during the first 2-3 months as the root system is less developed. To get a commercial crop from the seedling it takes nearly three years of growth in the field the sand beds the plants are transferred to plastic bags containing a planting mixture of equal amounts of sand, soil and farmyard manure. After about six months of growth in the nursery they are planted out in the field. It takes normally three years to get a commercial crop from single node leaf cuttings of D. floribunda.

This method is not being commercially used as it is considered slow. Its main use lies in faster multiplication of selected clones.

COMMERCIAL CROP FROM TUBER PIECES

The preferred method for propagation of D. floribunda for commercial planting is from tuber pieces. Anatomically D. floribunda tuber is a swollen hypocotyls. Therefore, except for the crown where is a growing bud, the rest of the tuber does not have any performed buds.

This method is being used now for raising of commercial crops. In the following sections details are described on various aspects of growth where tuber cuttings are used as planting material.

PORTION & SIZE PLANTING TUBER PIECES

Tubers can be divided into three distinct parts, namely, crowns, medians, and tips. The crown has a preformed bud the other two parts do not have any performed buds. Under specific conditions of storage they do develop adventitious buds. All the three pieces can be used for propagation.

The crowns normally take about 30 days to sprout where as the median take 90-100 days. The high yield of plants raised from the crowns is partly due to their early sprouting. However, other factors are also involved as when sprouting of crowns and medians are synchronized the plants raised from crowns still give relatively high yield in these different and genetically alike tuber sections.

The plants rose from bigger tuber pieces (80-100gm) significantly out yield the plants raised from bigger tuber (40-50gm) but the increased yields from the bigger pieces are not proportional to their size. Taking all factors into consideration, optimum planting piece size is recommended to be 40-50 gm.

PRE – TREATMENT OF TUBERS BEFORE PLANTING

The tubers are susceptible to a number of species of soil borne pathogens. Unless treated with proper fungicide shortly after harvest, the rotting can be severe. Treatment with 3000 ppm solution of Benomyl for ½ hours followed by dusting of cut-ends with 0.3% Benomyl in talcum powder gives effective control.

STORAGE OF CUT TUBERS

Direct planting of tuber pieces in the field immediately after harvest is not recommended as it involves avoidable expenditure on irrigation, weeding and other operations in the field for about one to three months when sprouting can be spent in moist sand beds. The tubers are planted in the field when sprouting in the sand beds is about 70% complete. The tubers should be cut for planting before storage. If whole tubers are stored in sand beds only the crown regions sprout when tubers are cut subsequently, ie, before planting, the medians and tips again take 90-100 days to sprout. Apparently sprouting of grown portions in the whole tubers suppresses the formation of the buds on other parts of the tubers. When the tubers are cut into different portions the effect of 'apical dominance' is removed.

The sand beds consist of alternating layers of sand and tubers. The beds are usually 90cm wide and about 300 cm long with 4-5 layers of tubers between different layers of sand. sand beds should be watered regularly and should be under shade.

LAND PREPARATION

Land should be prepared thoroughly 3-4 times with a mould-board plough till fine tilth is obtained D. floribunda plants have high requirement of organic matter for good tuber formation. Farmyard manure at the rate of 18 -25 tonnes per hectare should be applied at the time of field preparation.

TIME OF PLANTING

Experiments conducted on time of planting of tuber under Bangalore conditions have indicated that if the crown portions of tubers are used as planting material, the maximum yield is obtained by undertaking planting in mid. February. In case of medians and tips planting should be completed by the end of January.

SPACING

It has been observed that a spacing of 60cm*45cm was optimum for a two years crop of D. floribunda.

METHOD OF PLANTING

Planting of tuber pieces brought from the stored area should be done in furrows. Deep furrows are made at made at 60 cm level. The new sprouts need immediately staking. After one month the plants are earthed up thus making ridges in between the rows into furrows, and converting the original furrows into ridges with plants on them.

SUPPORT FOR THE PLANTS

The dioscorea vines need support for their optimim growth. The system tried successfully at Bangalore consists of stone pillars of 1.95m to 2.1m high and spaced at 6m apart in the field. The interconnecting wires can be of 12 gauge or strong ropes if they are cheaper. Each plant is supported by gunny twines regged to the grownd and tied to the overhead wires.

WEEDING

Initially the vines are week and tender. They cannot compete efficiently with the surrounding weeds. Periodic weeding as and when necessary is essential in the first year. In the second year the weed population is considerably reduced due to shading. The plants by this stage can complete more successfully.

Inter-cropping with legumes like cowpea and horsegram has found to smother weeds. These crops can be incorporated into the soil just before their flowering stage thus adding organic matter to the soil.

FERTILIZATION

D. floribunda responds well to nitrogen. In our experiments no appreciable response was observed with phosphorus and potash. The response to nitrogen was linear upto a level of 30 kg nitrogen per hectare. Increases in yield due to nitrogen in two year old crops of D. floribunda.

PLANT PROTECTION

No major pests and diseases have been observed mites were observed on this crop during last reason 0.05% of Rogor proved effective against mites.

DURATION OF CROP

A two years crop was found to be more economical on an average a two year old plant will yield 2.5 to 3 kg of tubers. The diosgenin content is around 3.0 to3.5%.

HARVESTING

Harvesting of tubers can be done by manual lab our with pick-axes of by deep ploughing with heavy mould board plough at proper moisture content

of the soil. The tubers of this species grow about 25cm to 30cm deep in the soil.

YIELD POTENTIAL

An average yield level of 50,000 to 60,000 kg of fresh tubers after two years growth can be expected from a hectare.

CONCLUSION

Pharmaceutically, the rhizomes are used as rich source of diosgenin. Diosgenin being steroidal in structure is used as precursor for several corticosteroids, sex hormones. Dioscorea is used in the treatment of rheumatic arthritis.

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AYURVEDA

1. INTRODUCTION

Ayurveda, the Indian indigenous system of medicine, dating back to the vedic ages (1500 -800 B.C), has been an integral kpart of Indian culture (weiss 1987). The term "Ayurveda" comes from Sanskrit root, ayu = life and veda = knowledge. These name implies, not only a science of treatment of the ill but also covers the whole gamut of happy human life, involving the physical, metaphysical and the spiritual aspects. According to Susruta, "the first aim of ayurveda is to help people maintain health and the treatment of diseases is only secondary aspect". Caraka, one of the foremost exponents of ayurveda, has defined "it is the science with instructs about life".

Therapeutically ayurveda in tackling a disease, aim to remove the root cause or aetiology of a disease, by planning a treatment based on an all-out drive of both offensive and defensive mechanism of drug, proper environmental consideration and the regimen.

2. Ayurvedic concept of man and nature

The ancient Indian medicine is based on the concept of a fundamental identity between man and nature. Man is considered to be a microcosm of the macrocosm, both being constituted by the panchabutas (five fundamental elements) namely Prthvi (earth) Akasa (space) and Vayu (air). Each of these can be perceived by their distinctive quality such as prthvi by gandha (odour),

APU by rasa (taste), Tejus or Agni by rupa (form) Vayu by sparsa (touch) and akasa by Sabda (Sound).

Life is sustainable only to the period through which this union and afterwards the human being decays and disintegrates into lthe fivce basic elements it is formed of.

3. Concept of Swasmya (health) and Roga (disease)

During his life time, man derives everything essential for life through food. The food is digested by gastric Juices and digestive enzymes and then the consequent digestion. Contributes to the development of the Saptadhatus (Seven harbingers of life) There are, Rasa [(lymph), readily absorbable essence of digested food], Rakta (Blood), mamsa (flesh), meda (Adipose tissues) Asthi (bone), Majja (bone marrow), Sukla [(sexual vital fluid) reproductive element].

These are involves into the biological structure and organization of the body. During this process, however, some waste products like urine, faeces and sweat are also produced.

Ayurveda recognized some structural basis of the living body, in functional terms as three different biological systems – Vata, Pita and Kapa. Vata is the nerve force which control all movements in the kbody. While pitta takes care of chemical reactions and biosynthesis of various compounds within the body system. "Kapha" is deals with balanced growth, development and functioning of the body.

When these three are well harmonized and function in a balanced manner. It results in good nourishment and well-being of the individual. But when there is an imbalance or disharmony within or Between them. It will leads to various kinds of ailments. So, the primary purpose of Ayurveda is to help the people who maintain Vata, Pitta, and Kapha in the balanced state and thus to prevent disease. Ayurveda does not pertain (Care) only to bodily health. It also takes care of the metaphysical and spiritual improvements or needs of man to acquired healthy attitude towards life.

Ayurveda defines roga (disease) as the state of misery either of body or mind or both. Susruta has recognized four different kinds of diseases.

1. Agantuja - due to external reason
2. Saririka - Physical
3. Manasika - mental
4. Svabhavika - natural

of these, "Agantuja roga" are caused by external reasons like accidents (cuts, burns, poisons bites), "Saririka roga " is the diseases due to vitiation of

dosas in the body system and patho-genic attacks are curable of Ayurvedic treatment.

"Svabhavika roga" are those painful experiences that go with human life as a matter of natural course. Such as birth, old age, death, urges of hunger thirst and sleep.

4). The PANCHASHEEL and the TRIDOSA

The concepts of Ayurvedic therapeutic rests on the five well defined pharmacological principles of Rasa, Guna, Virya, Vipaka and praphara. These five principles are called as panchasheel or five pillars of Pharmacology on which is built the edifice of Ayurvedic therapeutics. These five principles, as a rule cover the entire range of diseases whether of constitutional character or microbiological origion also.

More over, these five principles or five pillars of Pharmacology have their foundation on the bed-rock of "Tridosa theory" of Ayurvedic Physicopathology. The human body is supposed to have three states due to three different kinds of forces : These are called Vata, Pitta, and Kapha. When these are disturbed it will cause diseases. They are called doshas. The Tridoshas are nothing but equal to the wind, bile and Phelgm respectively. They represent an aggregate of life, system which like any motive system has two counterparts. Viz., An organic body and an energy system, the latter acting upon the formers.

According to the real purport of this theory, it can be rightly interpreted that the entity. "Kapha' stands for the organic body, whereas the energy sysem is being represented by the entities Vata and Pitta. On other words Tridosa as a whole life inearnated in which "Kapha" is the organic body and "Vata" and "Pitta" are its functional counter part.

In the above light the reality of Tridosa is conceivable in any life system. As a matter of fact Tridosha is incarnated as it were, even in an unicellular Organisms as pathogen or non-pathogen. Pertinently another point o realize, Tridosa the Life System – is symbiotically connected with the cosmos in which, as a rule, it originates, exists and ultimately perishes. (eg. Sristi-sthiti Vinashanam).

The Correlation between the "Tridosa" and the "Panchasheels"

There exists of correlation between the physio-pathology of Tridosa system and the Pantafacet – pharmacological principles of Rasa, Guna, Virya, Vipaka and Prabava which in the form of biochemical and biophysical attributes, reside in the matter itself. While Guna and Virya represent the biophysical attributes, the remaining three principles concern with the attributes

of Biochemical nature. From the therapeutic point of view, matter has been designated as "Dravya" and thus in Ayurveda the book on therapeutics is called Dravyaguna.

According to Ayurveda, restoration to the normal balance amongst vata, pitta and kapha and thus ensuring health, can be effected by applying all the five principales of Pharmacology acting together. Because, they, in fighting the diseases, Play the dual role of the effensive and defensive aspects of the treatment. In this dual role of medicine. Prabhava principle exerts the offensive mechanism of drug action, and the rest of the four principles mainly play the part of defensive mechanism. More over, this five principles, only the "Prabhava" principle furnishes a common therapentic basis both for the Ayurvedic drugs and drugs of the modern medicine.

An Elucidation of the "Panchasheel"

Rasa, Guna, Virya, Vipaka and Prabhava are five pharmacological Principles, called as panchasheel of Ayurveda.

Rasa

'Rasa' means taste ; they are basically six in number, viz, sweet (madhura), sour (amla), saline (lavana), pungent (katu), bitter (tikta) and restringent (Kasaya). They singly or incombination can affect the individual entity of the Tridosa to the extent they get the scope, and there by disturb the balance (i.e physiological state) or imbalance (i.e. Pathological State) in lthe latter case, by this type of disturbance they perforce, can bring about an alternative effect by their hypo or hyper-association with the entities of Tridosa and thus help the system get and of the imbalance, i.e. diseased.

For example, the effect of the first three Rasas, viz. Sweet, sour and saline in acute cold. A patient who is suffering from the acute cold has caused to get his level of Kapha-dhatu (lymph and lymphoids) elevated from the normal. According to the Ayurveda sweet, sour and saline tasting substances augment the Kapha-dhatu, sweet having the highest capacity and rest of the two in their respective order. Obviously, in the case of acute cold if a person takes sweet and sour tasting substances he will comply aggravate his condition. In such deses he should, at the first instance lastain from taking them. Secondly as a remedial measure he should positively take in the form of a long substances with pungent bitter and astringent tastes. In this connection it must be borne in mind that all carbohydrates, protein, fats and water will come under sweet and sour tasting substance.

Guna

Guna means certain physical properties of matter (i.e drug and food). They affect the balance or imbalance of Tridosa in health and disease respectively, by the overwhelming action of their positive or negative values. Residing in the matter itself of hotness notwithstanding both belonging to the same chemical group, i.e. the glyceride of fatty acids Naturally, Viryas of drug and food can influence the balance or imbalance or imbalance of Tridosa, in health and disease respectively through the hypo or hyper – association of any one of them.

Paka : Vipaka, by this Ayurveda means that the end products of all digestive transformation (Rasas) are either sweet (madhura) or sour (amla) not-withstanding the original matter (i.e. drugs and food) having a different taste. There are three kinds of Vipaka.

In some cases, the taste of the substances gets transformed or changes it's nature in the stomach. Say, some acrid (Katu) substances change over to sweet when acted upon by the digestive juices and the effect would be that of sweet and not acrid. This is called rara-vipaka. They in their reciprocal opposite values are shown here in pairs, viz. heaviness (Guru) Vs. lightness (Laghu); oiliness (Shigdha) vs. roughness (Ruksha); viscidity (Sandra) Vs. antivisicidity (Visada); mobility (Chala) vs. antimobility (Stiria) tangibility (sthula) vs. attenuatedness (Suskshma), etc.,

Virya :Virya denotes two intrinsic properties of matter (i.e drug and food) viz., 'Sita-virya' and 'Usna-virya'. The former has the attribute of coolness and the latter of hotness. Gross example may be found in the effects of sugar and pepper in the system. Sugar has the effect of coolness and pepper of hotness. In a very finer sense the case of Virya may be real in the difference of effects between butter and oil. Intrinsically butter has the property of coolness, whereas oil has the property generally imparted by the modern well defined chemical entities like alkaloids, clyeosides, antibiotics and anti bacterials, vitamins, trace elements and so many other organic active principles present in drug or food. In the case of food vitamins definitely play the role of prabhava principle of drug action generally exerts a quick effect, both in the course of constitutional and bacterial diseases Bacterial disease are not alien to (Ayurveda).

Prabava principle, directly and quickly too, influence the imbalance of Tridosa to bring about an alternative effect in a spectacular way which may help restoration to the system of the normal balance. But Ayurveda maintains, to get a sustaining effect in upholding the normal balance, the other four

principles must act concurrently in the form of drug, regimen and environment too.

In certain other cases, the virya of the substance gets transformed in the stomach usna-virya gets transformed into Sita-virya and vice-versa.

This called “Virya-Vipaka”.

In “Samskara-Vipaka”, the substances when subjected to certain processes get transformed with different properties or can be targeted to a specific site or organ. For e.g. Papaya fruit is by nature, Usna-Virya but when taken with lime juice, it becomes sama-virya.

Prabhava : This Pharmacological Principle, last in the series, denotes certain special power of the substance-either drug or food. Prabava does its action quite independent of the other four basic principles lof Pharmacology, viz. Rasa, Guna, Virya and Vipaka. It is quite apt to compare prabhava will all the pharmaco- therapeutic actions.

The Basic Difference Between the Pharmacology of Ayurvedic and Modern medicine :

Modern Pharmacology being compartmental in nature, i.e. organ or issue-wise evaluation of drugs, mostly done through animal experiment and on the basis of Physiological responses to them, an idea of finding out a comparison or correlation of it with Ayurvedi Pharamacotheropeutics does not hold good quite properly against the background elucidated above.

Drugs of modern medicine, pharmacologically developed and accepted in the therapeutics, act in a limited manner. For example acidity in neutralized by antacid. As an antacid has no capacity to attack the root cause of acidity and effect a permahent cure, similarly a drug like reserpin is unable to remove the causative factor of hypertension, no doubt it brings about a spectacular relief, more or less like a sort of mechanistic (ef. Pharmacodynamic). Exactly similar is the case with insulin in diabetes. In one expression in can be said that while amelioration of alleviation of distressing symptoms is definitely provided by many drugs of modern medicine in a number of cases, specially in constitutional diseases, The permanent cure cannot be found of this five Pharmacological principles of Ayurveda, that only the Prabhava principle furnishes a common medicines. The role of the remaining four principles are being quite ignored by the protagonists of modern medicine.

So far as the drugs of modern medicine are concerned the specificity of drugs action is the axiomatic outlook and endeavour, when the basic Philosophy of this system of medicine admits the theory of specific involvement of the organ and tissue in producing a disease. In contrast, the

Ayurvedic therapeutic basis, similarly an axiomatic development on the Tridosa theory of life system, is quite broad based.

Ayurvedic divisions :

The earlist works of Ayurveda that we have today are the sambitas of carakas and suruta (before 600 B.C) jodified and supplemented by later authors. In its pristine form, Ayurveda was divided into eight subjects.

Salya (Surgery)

Salakya (ENT and Opthalmolgy)

Kayacikitsa (general medicine)

Bhutavidya (Curing influence of evil spirits psychiatry)

Kaumarabhrtya (Paediatrics)

Agadatantra (toxicology)

Rasayana (treatment for rejuvenation of the body)

Vajikarana (treatment for acquiring virility)

GROUPING OF DRUGS

Vegetable drugs in Ayurveda the grouped under two distinct heads namely the “Botanical indices” and the “therapeutic indices”.

Following several sub-groups

Puspa verga: (Flowers having medicinal value)

Padma (Nelumbo. Nucifera)

Kumuda (Nymphaea sp.)

Juthika (Jasminum sp.)

Champaka (Michlelia champaca)

Bakula (Mimusops elengi)

Kadamba (anthocephalus cadamba)

Dhataki (Woodfordia fruticosa) etc.,

Phala varga: (Fruits having medicinal value)

Amra (Mangifera indica)

Jambu (Syzygium cumini)

Kapittha (Feronia elephantum)

Madhuka (Madhuca indica)

Tintidi (Tamarindus indica)

Khajura (Phoenix dactylifera) etc.,

Shaka varga: (Leaves/whole herb having medicinal value)

Vastuka (Chenopodium album)

Marisha (Amaranthus blitum)

Hilamochika (Enhydra fluctuans)

Champaka (Cicer arictinum)

Sushinnaka (Marsilea (minuta))

Kasamarda (Cassia occidentalis) etc.,

Phala shaka varga: (Non-dessert fruits having medicinal value)

Kusmanda (Benincasa hispida)

Karavella (Momordica charantia)

Patola (Trichosanthes) cucumerina)

Bimba (Coccinia indica)

Koshataki (Luffa sp.)

Shobhanjana (Moringa oleifers) etc.,

Kanda shaka varga: (Underground parts like rhizome, bulbs, tubers, etc having medicinal values)

Shurana (Amorphophallus camapanulatus)

Manaka (Alocasia indica)

Lasuna (Allium sativum)

Palandu (Allium cepa)

Mulaka (Raphanus sativus)

Grinjana (Daucus sativus) etc.,

Hariltakyadi varga

In this botanical grouping so many medicinal plants of different families have been collectively put together, of which baritaki is the prime member, am ongst a total of 92 drugs. Eg.,

1. Haritaki (Terminalia chebula)
2. Amalaki (Emblica officinalis)
3. Bibhitaki (Terminalia belerica)
4. Daruharidra (Berberis / Coscinium sp.)
5. Katuka (Picorhiza kurroa)
6. Bhallataka (Samecarpus anacardium)
7. Vidanga (Embelia ribes)
8. Bhanga (Cannabis indica)

9. Yasthimadhu (Glycyrrhiza glabra)

In these fruits of the first three terms of the above list when combined snake the very famous and popular Ayurvedic recipe triphala which is successfully indicated in a variety of elements like constipation, acidity and even eye troubles.

Guduchyadi Varga

Under this group the total number of drugs involved are 124, of which the first member is Guduchi. A few of them are cited here eg:

1). Guduchi (Tinospora Cordifolia)
2). Langalika (Gloriosa Superba)
3). Karovira (Nerium indicum)
4). Dhustura (Datura metel)
5). Nimba (Azadirachta indica)
6). Nirgund (Vitex negundo)
7). Kutaja (Holarrhena antidysentrica)
8). Karanja (Pongamia Pinnata)
9). Ashwagandha (Withania somnifera)
10). Ananta (Hemidesmus indicus) etc.,

Karpuradi Varga : (Aromatic plants having medicinal value)

1). Karpura (Cinnamomum Camphora)
2). Chandana (Santalum album)
3). Devadaru (Cedrus deodara)
4). Tagara (Valeriana Wallichii)
5). Guggulu (Comuniphora mukul)
6). Lavanga (Syzygium aromaticum)
7). Ela (Elettaria Cardamomum)
8). Kumkuma (Crocusativus) etc.,

Vatadi Varga

This groups has forty – three members of which the first member is vata :

1). Vata (Ficus bengalensis)
2). Ashwattha (Ficus religiosa)
3). Udumbara (Ficus recemosa)
4). Khadira (Acacia Catechu)
5). Varuna (Crataeva nurvala)

6). Saptaparna (Alstonia Scholaris) etc.,

Therapeutic Indicus

This group of drug have the ability to nullity the diseased condition brought about by the Tridosic Upset the system. Group wise they may be called "Anti-Vatic drugs", "Anti-Paittic drug", Anti-Kaphic drugs numerically they are limited in numbers.

A. Anti – Vatic drugs : (Vataghua)

1. Rasna (Alpinia officinarum) – (Its official ayurvedia substitute is vandal voxburghii, which has been found effective by several (vecearchers):
2. Tagara (Valeriana Wallichii)
3. Prasarani Paedaria foetida)
4. Eranda (Ricinus Communis)
5. Charaka considers Rasna as the best amongst the Ant-vatic drug (Sutrasthan 25 ch; item 35)

B. Anti – paittic drugs (Pittaghna)

1. Patola patram (Trichosanthes dioica)
2. Vetra (Calamus rotang)
3. Durva (Cynodon dactylon)
4. Parpata (Oldenlandia biflora)

C. Anti – Kaphic drugs : (Kaphaghna)

1. Pippali (Piper Longum)
2. Maricha (Piper nigrum)
3. Tambula (Piper betle)
4. Kantikari (Solanum Kanthocarpum)
5. Shobhanjana (Moringa Oleifera)
6. Tulsi (Ocimum sanctum)

Summary

To summarize, we may say that in a more comprehensive manner the fundamental basis of Ayurveda is cosmologically related to the theories of pancha mahabhoota- Pancha Tammatra – Tridosa in the one hand and Rasa – Guna – Virya – Vipaka – prabhava principle of Pharmacology on the other hand – constituting together a grand aura of biophysical and biocherrvical laws which govern the human life in health and disease.

Conclusion

The Allopathic medicine has no cure for many chromic and refractory diseases – for eg.Diabetis, Rheumatoid arthritis, Bronchial asthma etc., Besides, the modern medicine also produce many unwanted side effect and more expensive. So, disillusioned with the Synthetic western medicines, more and more people are now realising that "Natural is better" and are returning to the fold of traditional herbal system.

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Unit – II

(A) HISTORY, DEFINITION AND SCOPE OF PHARMACOGNOSY

NATURE always stands as a golden mark to exemplify the outstanding phenomenon of symbiosis. The biotic and abiotic elements of nature are all interdependent. The plants are indispensable to man for his life. The three important necessities of life – food, clothing and shelter – and a host of other useful products are supplied to him by the plant kingdom. Nature has provided a complete store-house of remedies to cure all ailments of mankind. The knowledge of drugs has accumulated over thousands of years as a result of man's inquisitive nature so that today we possess many effective means of ensuring health-care.

The human being appears to be afflicted with more diseases than any other animal species. There can be little doubt then that he, very early, sought to alleviate his sufferings from injury and disease by taking advantage of plants growing around him. In the past, almost all the medicines used were from the plants, the plant being man's only chemist for ages. Today, a vast store of knowledge concerning therapeutic properties of different plants has accumulated. All phyla of plants viz. Thallophyta, Bryophyta, Pteridophyta and Spermatophyta, (of which conservative estimates place the total number of known species at approximately 3,35,000) contain species that yield official and unofficial products of medicinal importance. By far, the greatest number of these are derived from plants and include three hundred or more recognized families of Spermatophyta).

The history of herbal medicines is as old as human civilization. The documents, many of which are of great antiquity, revealed that plants were used medicinally in China, India, Egypt and Greece long before the beginning of the Christian era, One of the most famous surviving remnants is Papyrus Ebers, a scroll some 60 feet long and a foot wide, dating back to the sixteenth century before Christ. The text of document is dominated by more than 800 formulae and 700 different drugs. The drugs such as acacia, castor oil and fennel are mentioned alongwith apparent references to such compounds as iron oxide, sodium chloride, sodium carbonate and sulphur. Most of the medicinally active substances identified in the nineteenth and the twentieth centuries were used in the form of crude extract. In China, many medicinal plants had been in use since 5000 B.C. The oldest known herbal is Pen-t'sao written by emperor Shen Nung around 3000 B.C. It contains 365 drugs, one for each day of the year. Indians also, worked meticulously to examine and classify the herbs which they came across, into groups called Gunas. Charaka made fifty groups of ten herbs each of which, according to him, would suffice an ordinary physician's need.

Similarly, Sushrutha arranged 760 herbs in 7 distinct sets based on some of their common properties. A large portion of the Indian population even today depends on the Indian System of Medicine – Ayurveda, 'An ancient Science of life'. The well known treatises in Ayurveda are Charaka Samhita and Sushrutha Samhita.

Following the contribution to medicine by Hippocrates "Father of Medicine", (460 –360 B.C.), Aristotle (384 – 322 B.C), Dioscorides (40 – 80 A.D) Galen (131 –200 A.D) and the early Arabian physicians, there was a period of approximately 1000 years during which little, if any, progress was made in the medical sciences. The first pharmacist, Galen, was known to have had a number of painrelieving materials, including opium in his apothecary. For the next few hundred years, the formulations of the medicaments in use changed very little, although some bold attempts were made by chemical entrepreneurs such as Paracelsus (1493-1541) to develop mineral salts which might have had the potential of being universal curative agents. However, throughout this period, the use of herbal extracts for medicinal purposes never lost its place.

The importance of the extraction method and alcohol as an extractant was reported by Le'mery (1645-1715). William Withering in 1785 published an account of some of the medicinal properties of foxglove leaves based on ten years of experimentation. Percolation process was used for the crude drugs Calumba, an alkaloidal drug, became official in 1788. In 1803, the French pharacist, Derosne isolated narcotine from opium. In 1806, Sertuerner isolated morphine from opium and its role in alleviating pain was recognized. In the next few years, strychnine (1817), emetine (1817), emetine (1817), brucine (1819), piperine (1819), quinine (1820) and colchicines (1820) were isolated. The French Pharmacist, Pelletier first reported the isolation of strychnine from Ignatius beans and later from nux vomica seeds. A new extraction process for alkaloid was developed by Stass and Otta in 1853. Other important discoveries during this period were the isolation of nicotine from tobacco leaves (posselt and Reimann, (1828), cocaine (Neumann, 1860), ouabain(Hardy and Gallows, 1877), pilocarpine (Gerrard and Hardy, 1875) ephedrine (Nagai, 1887) and podophyllotoxin (Kuersten, 1891). Isolation of ergometrine, digoxin, reserpine,

herbal extracts for medicinal purposes never lost its place. throughout this period, the use of

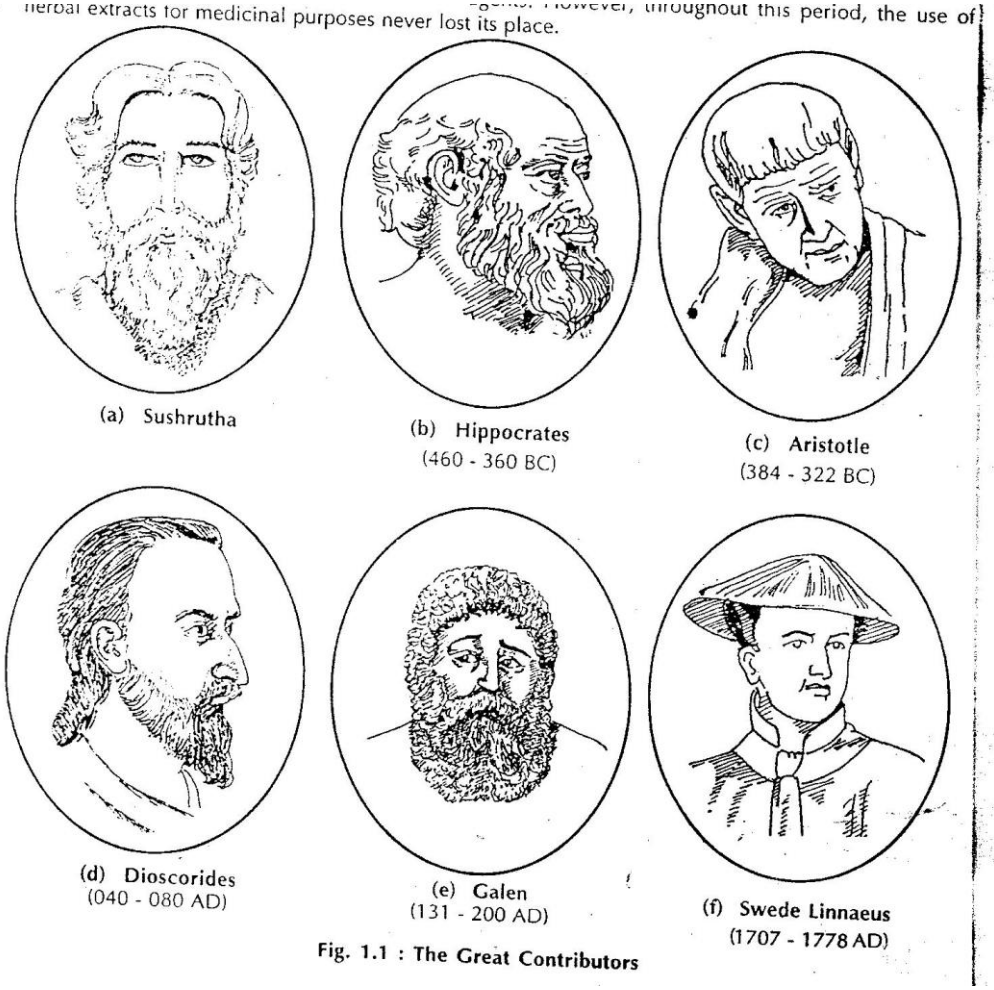


Fig. 1.1 : The Great Contributors

theophylline and quinidine are the significant discoveries of the twentieth century.

In the nineteenth century, the term 'Materia Medica' was used for the subject now known as "Pharmacognosy". While studying Sarasaparilla, it was Seydler, a German scientist, who coined the term "Pharmacognosy" in 1815 in the ;title of his work "Analecta Pharmacognostica". Pharmacognosy is derived from two Greek words viz. Pharmakon (a drug) and Gignosco (to acquire the knowledge of).

Pharmacognosy may be defined as a branch of bioscience which treats in detail medicinal and related products of crude or primary type obtained from plant, animal and mineral origins. In short, it is an objective study of crude drugs from natural sources treated scientifically and it encompasses the knowledge of the history, distribution, cultivation, collection, processing for market and preservation, the study of sensory, physical, chemical and structural characters and the uses of crude drugs. Pharmacognosy also includes study of other materials used in pharmacy such as suspending, disintegrating and

flavouring agents, filtering aids, etc. and substances like antibiotics, allergens, hallucinogenic and poisonous plants, immunizing agents, pesticides, raw materials for the production of oral contraceptives etc.,

Swede Linnaeus (1707 – 1778) the great systematist classified the plants and introduced the system of naming the plants known as the binomial system which is still followed.

The progress achieved in botanical studies during 19^{th} century had a direct influence on Pharmacognosy. Plant classification was further developed by Bentham and Hooker (1862-1863), A.W. Eichler (1883), Engler and Prandtl (1887-1898). In 1865, G.Mendel's important observations on plant hybrids were published. The introduction of the microscope, as an important analytical tool, was a landmark advancement in botanical research, especially due to the development of several techniques : clearing, mounting and staining kof the preparations. The anatomical atlas of crude drugs was published by Berg in 1865. Later in the centurly, Voehil, Tschirch and others reported the anatomical characters of several powdered drugs which proved to be of great significance especially at a period when adulteration in both drugs and food articles was common. 'An Anatomical Atlas of Powdered Vegetable Drugs was compiled in 1904 by Greenish and Collin.

Pharmacognosy as an applied science has played a crucial role in the development of different disciplines of science. A pharmacognosist should possess a sound knowledge of the terms; used to describe the vegetable and animal drugs as covered under botany and zoology, respectively. The knowledge of plant taxonomy, plant breeding, plant pathology and plant genetics is helpful in the development of cultivation technology for medicinal and aromatick plants. Plant – Chemistry (Phytochemistry) has undergone significant development in recent years as a distinct discipline. It is concerned with the enormous variety of substances that are synthesized and accumulated by plants and the structural elucidation of these substances. The technology involving extraction, purification and characterization of pharmaceuticals from natural sources is a significant contribution to the advancement of natural and physical sciences. The knowledge of chemotaxonomy, biogenetic pathways for formation of medicinally active primary and secondary metabolities, plant tissue culture and other related fields is essential for complete understanding of Pharmacognosy. The basic knowledge of biochemistry and chemical engineering is essential for development of collection, processing and storage technology of crude drugs.

Pharmacognosy is an important link between Pharmacology and Medicial Chemistry. As a result of rapid development of phytochemistry and pharmacological testing methods in recent years, new plant drugs are finding their way into medicine as purified phytochemicals, rather than in the form of traditional galenical preparations. The knowledge of pharmacology is essential for understanding action of drugs on animals and the human system. Pharmacognosy is the infrastructure on which depends evolution of novel medicines, as it is seen that several crude drugs are utilized for preparation of galenicals or as sources of therapeutically significant substances that cannot be synthesised economically. Further, the crude drugs also provide essential intermediates for final synthesis of active compounds. Phytopharmaceuticals or synthetic drugs derived from phytochemicals have to be ultimately incorporated in suitable dosage form which involves the knowledge of dispensing and preparative pharmacy, pharmaceutical technology and analysis.

In anutshell, Pharmacognosy is an important bridge between the pharmaceutical and basic sciences. Pharmacognosy is a vital link between Ayurvedic and Allopathic systems of medicines. It provides a system where in the active principles of crude drugs derived fromnatural origin can could be dispensed, formulated and manufactured in dosage forms acceptable to allopathic system of medicine.

(B) TRADITIONAL AND ALTERNATIVESYSTEMS OF MEDICINES

Traditional Chinese Medicine and Kampoh System

The Chinese system of medicine is still prevalent. This ancient system finds its references in the Yellow Emperor's classic of Internal Medicine (Huang di Nei Jing) which is believed to be prepared between 200 BC and 100 AD. This herbal is based on the idea that all life is subject to natural laws. The hypothesis includes two quite different systems the yin and yang theory and the five elements (i.e. water, metal, earth, fire and wood). These two theories have been developed separately and differ in terms of diagnosis and treatment. The yin and yang theory says that everything in the universe consists of a dark (yin) and light side (yang). These are complimentary opposites like wet and dry, up and down or day and night. The five elements theory proposes that each element leads to the next in a continuous fashion like fire to metal, to wood, to earth, to water and so on. The elements are the five phases indicating the process of continuous movement of life. The elements play a dynamic role in the Chinese system of medicine like in making groups of herbal tastes and parts of body.

According to this system, diseased conditions are the expressions of imbalance in yin and yang like excess or deficiency of either of them. For example, shivering occurs due to excess of yin while excess of yang causes a fever. The treatment makes use of various herbs especially the formulations. The important herbs from this system are Ephedra sinica, Rheum palmatum, Carthamus tinctorius, Clerodendron trichotomum, Panax ginseng, Schisandra, Chinensis, Schizonepeta tenuifolia, Agastache rugosa etc.

The traditional Chinese system of medicine has spread to Japan and Korea in a form called Kampoh, called as the traditional system of Japanese medicine. Although, it has developed its own characters, giving due importance to the Japanese style of simplicity and naturalness, still the basic ideas like yin and yang have a crucial role in Kampoh medicine. As compared to Kamoph, Korean system is very much similar to Chinese system and includes most of the herbs in it.

Ayurveda – Indian System of Medicine

Ayurveda – Ancient Science of Life is believed to be prevalent for last 5000 years in India. It is one of the most noted systems of medicine in the world. Ayurveda is based on the hypothesis that everything in the universe is composed of five basic elements viz. space, air, energy, liquid and solid. Theyexist in the human body in combined forms like vata (space and air), pitta (energy and liquid) and Kapha (liquid and solid). Vata, pitta and Kapha together are called Tridosha (three illars of life). It is believed that they are in harmonywith each other, but in every human being one of them is dominating which, in turn is called as the prakruti of that person. Tridosha exist in human bodyin seven forms called Saptadhatu viz. Rasa (Iymph), Rakta (blood), meda (adipose tissue), mamsa (flesh), majja (nervinetissue), Shuukra (reproductive tissue) and asthi (bones). These tissues are subject to wear and tear so that mala (excretory material) is formed from them. When tridosha, saptadhatu and mala are in balance with each other, it is called as healthy condition while imbalance causes a pathological condition. It is hypothesized that the five characters of the medicinal herbs viz. rasa, guna,virya, vipak and prabhava can be applied to treat various pathological conditions. Authenticinformation on Ayurveda has been compiled by ancientIndian Medicine practitioners in forms called Samhita and othersimilarbooks. Ayurvedic pharmacy (Bhaishajya – Vigyan) proposes fivebasic dosage forms like swaras, kalka, kwath, hima and phant. A number of other dosage forms like churna, avaleha, ghrita, sandhana kalpa, bhasma are prepared from them. Mostly, all of them are polyherbal formulations. Some important herbs in Ayurveda are Rauwolfia sepentina,

Asparagusracemosus, Cassia angustifolia, Sesamum indicum,Holarrhena antidysenteria, Withania, somnifera, Aconitum napellus, Piper longum, etc.

Unani System of Medicine

The roots of this system go deep to the times of the well known Greek philosopher Hippocrates who is credited with it. Aristotle Golen (384 – 322 BC) Greek – Philosopher "Father of natural history" made valuable contributions to it. This system of Greek origin was further carried to Persia (Iran), where it has been improved by Arabian physicians.

This system is based on two theories viz. the Hippocratic theory of four humours and the Pythagorian theory of four proximate qualities. The four humours are blood, phlegm, yellowbile and black bile while the four qualities are thestates of living human body like hot, cold, moist and dry. They are represented as earth, water, fire and air. The Greek ideas were put by Arabian physicians as seven working principles (Umur-e-Tabia) and included elements, temperaments, humours, organs, life, spirit, energy and actions. They believed that these principles are responsible for the body constitution and its health, as well as, the diseased conditions.

The Unani system of medicine aims at treating the cause of disease and not its symptoms. For this purpose, thorough history of the patient is recorded in addition to his pulse, urine and stool examinations. The diseased condition is considered to be due to the imbalance between humours and accordingly, treatment is given. The drugs are polyherbal formulations and their collective effect is considered.

Unani system of medicine is called by various names in different parts of world such as Arab medicine, Greco-Arab Medicine, Loniah medicine, Islamic medicine and also Oriental medicine.

Unani-medicines : Madar, fufal, Gilo, Kabab chini, Karanj, Kulthi, Lodh, Qust, Sana, Tagar, zeera, Siyah.

Homoeopathic System of Medicine

In comparison to other traditional systems of medicine,l Homeopathy is a newer one and has been developed in the eighteenth century bySamuel Hahhemann – a German physician and chemist. He proposed that the cause of diseaseitself can be used for its treatment. Hahnemann put forth the Law of Similars which says that like cures like (Similae Similibus Curentur). With this principle, he shows that cinchona can produce the symptoms of malaria. He succeeded in getting relevant results with a large number of extracts preparedfrom plants, animals and minerals. He compiled all these observations in what is called 'The Organon of Medicine.

In the homoeopathic system, the drug treatment is not specified, but the choice of drug depends on symptoms and the clinical condition of the patient. This is based on the concept of proving and prover. In a healthy person called prover, the symptoms created by different doses of drug extracts are noted which is called proving, and it specifically considers physical, mental and emotional changes of the prover. Consequently, these symptoms are compared with a patient with similar symptoms and accordingly, same type of extract is given for treatment. During the treatment, the drug extracts are extremely diluted, which is believed to cause potentiation and enhancement of curative effect. The drugs are extracted in the form of mother tincture, which is further diluted in terms of decimal or centesimal potencies. Various medicinal plants used in homoeopathy are Homoepathic system.

Vegetable drugs	Animal drugs	Mineralls and metals
Arnica, Belladonna, Marigold, Chamomile, Colchicum, Hemlock, Hyoscyamus, Hypericum, Ipecacuha, Lycopodium, Opium Ergot, Thuja, Aconite, Nux-vomica	Honey-bees, Carbonate, Cantharis	Arsenioxide,Barium carbonate, Calcium phosphate, Kalashisa, Mercuric chloride, Antimony tartarate, Sulphur, Copper Aluminium, Phosphorus, Platinum

Siddha System of Medicine

The term 'Siddha' means achievement and 'Siddhars' were saintly personalities, who attained proficiency in medicine through practice of Bhakti and Yoga. This is the system of pre-vedic period identified with Dravidian culture and it is largely therapeutic in nature. Like Ayurveda, this system believes that all objects in universe are made up of five basic elements namely, earth, water, sky, fire and air. The identification of causative factors of diseases is done through pulse reading, colour of body, study of voice, urine examination, status of digestive system and examination of tongue. The literature of Siddha system is mostly in Tamil.

Naturopathy and Yoga

Naturopathy is not merely a system of treatment, but also a way of life, which is based on laws of nature. The attention is particularly paid to eating and living habits, adoption of purificatory measures, use of hydrotherapy, mud packs, baths, massage, etc.

The system of Yoga is as old as Ayurveda. The eight components of Yoga are restraint, observance of austerity, physical postures, restraining of sense organs, breathing exercise, contemplation, meditation and samadhi. Yoga exercises have potential in improvement of better circulation of oxygenated blood in the body, restraining the sense organs, improvement of social and personal behaviour and induction of tranquility and serenity in the mind.

Bach Flower Remedies

Bach flower remedies were discovered by Edward Bach, a physician in the early decades of the twentieth century. These include 38 remedies prepared from flowers of wild plants, bushes or trees. The remedies are prescribed as per the patient's state of mind like, depression, anger, fear, worry, etc. The prescription is meant for achieving vitality and a harmonious state of mind, the lack of which causes sickness. According to Dr.Edward Bach, the remedies enrich the body with vibrations of human's superior nature, rather than attacking a disease. It is believed here that change of outlook and peaces of mind have a major role in healing of a disease. Some of the remedies prescribed are white chestnut, wild rose, mimulus, agrimony, chicory, gentian etc. Some states of mind for which they are prescribed are worry, vague, fear of unknown origin, despair, extreme mental anguish, extreme fright, lack of confidence, etc. For the purpose of medication, the mother tinctures are prepared and dispensed in a diluted form as in homeopathic potentiation.

Aromatherapy

It is one of the most ancient healing arts and traces its origin to 4500 B.C., when Egyptians used aromatic substances in medicines. Greeks also used plant essences for aromatic baths and scented baths (abhyanga). Prof. Gantle Fosse, a French cosmetic chemist coined the term 'Aromatherapy' and described healing properties of essential oils. Many scientists at various universities are, now-a-days, investigating this method of healing. Different essential oils from various parts of plants are massaged into skin to treat a range of diseases, as well as, to have an effect on the mind and emotions. They are massaged into the skin or inhaled or taken as bath. They have been shown to heal wounds, promote formation of scar tissue, treat achne and skin problems, pre-menstrual tension, rheumatism, poor circulation and also nervine disorders like headache, stress, insomnia, etc. Various essential oils used in aromatheraphy are basil, bergamot, black pepper, calendual, caraway, eucalyptus, fennel, garlic, geranium, ginger, jasmine, juniper, lavender, rosemary and sandalwood.

(C) CLASSIFICATION OF CRUDE DRUGS

The terms 'crude drug' generally applies to the products from plant and animal origin found in a raw form. However, the term is also applied to inclusion of pharmaceutical products from mineral kingdom in original form and not necessily only of organic origin such as kaolin, bentonite, etc. The term 'crude drug' is referred in relation to the natural product that has not been advanced in value or improved in condition by any process or treatment beyond that which is essential for its proper packing and prevention from deterioration. Crude drugs are further grouped as organized (cellular) or unorganized (acellular) according to whether they contain a regular organized cellular structure or not. Organized drugs comprise those crude drug materials which represent a part of the plant and are, therefore, made up of cells. Unorganised drugs are a diverse group of solid and liquid materials which do not consist of parts and are obtained from natural sources by a variety of extraction procedures.

In pharmacognosy, the drugs may be classified according to (i) their alphabetical status, (ii) the taxonomy of plants and animals from which they are derived, (iii) their morphology, (iv) the chemical nature of their active constituents, (v) chemotaxonomical status, and (vi) their pharmacological actions and therapeutic applications.

1. Alphabetical Classification

The crude drugs are arranged according to the alphabetical order of their Latin and English names. Some of the Pharmacopoeias and reference books which classify crude drugs according to this system are as follows:

(1) Indian Pharmacopoeia, (2) British Pharmacopoeia.

(3) British Herbal Pharmacopoeia (4) United States Pharmacopoeia and National Formulary,

(5) British Pharmaceutical Codex, (6) European Pharmacopoeia (Latin titles)

(7) Encyclopaedia of Common Natural ingredients used in Drugs and Cosmetics.

e.g. : Acacia, benzoin, cinchona, dill, ergot, fennel, gentian hyoscyamus, ipecacuanha, jalap, kurichi, liquorice, myrrh, nux-vomica, opium, podophyillum, quassia, rauwolfia, senna,l uncaria gambier, vasaka, wool fat, yellow bees-wax, zedoary.

2. Taxonomical (Biological) Classification

The drugs are classified according to plants or animals from which they are obtained in phyla, orders, families, genera, species, subspecies, etc. This

method of classification is based on the consideration of natural relationship or phylogeny among plants or animals. The crude drugs of plant origin are classified on the basis of one of the accepted systems of botanical classification. A large number of plant families have certain distinguishing characteristics that permit crude drugs from these families to be studied at one time. Thus, drugs obtained from plants having alternate leaves, cymose flowers and fruits that are berries or capsules (hyoscyamus, datura, belladonna and stramonium) are considered with other members of Solanaceae. In case of animals, all arthropods are grouped, as are all mammals, fish and other phylogenetic types. This system of classification is criticized for its failure to recognize the organized and unorganized nature of the crude drug. At first sight, this classification looks appealing, but many drugs are not entire plants and represent parts of the plants that have been processed systematically. Further, the system fails to take into an account chemical nature of active constituents and therapeutic significance of crude drugs.

The taxonomical classification for few crude drugs derived from dicot plants is as follows:

(i)	Phylum	-	Spermatophyta
	Division	-	Angiospermae
	Class	-	Dicotyledons
	Order	-	Rosales
	Family	-	Leguninosae
	Sub-family	-	Papilionaceae
	Genus	-	Glycyrrhiza, Astragalus, Myrozylon.
	Species	-	Glycyrrhiza glabra, Astragalus gummifer, Myroxylon balsamum
(ii)	Phylum	-	Spermatophyta
	Division	-	Angiospermae
	Class	-	Dicotyledons
	Sub-Class	-	Sympetalae
	Order	-	Tubiflorae
	Family	-	Solanaceae
	Genus	-	Atropa, Hyoscyamus, Datura
	Species	-	Hyoscyamus niger, Datura Stramonium, Atropa belladonna.
(iii)	Phylum	-	Thallophyta

Class	-	Ascomycetes
Order	-	Clavicipitales
Family	-	Clavicipitaceae
Genus	-	Claviceps
Species	-	Claviceps purpurea

3. Morphological Classification

The crude drugs are grouped according to the part of the plant or animal represented into organized and unorganized drugs. The organized drugs are divided into parts of plants like leaves, flowers, fruits, seeds, woods, barks, and subterranean parts like roots and rhizomes. The unorganized drugs are dried latex, gums, extracts, etc. Some of the examples of crude drugs under this type of classification are as follows:

Seeds - Nux-vomica, Strophanthus, Isabgol, Castor

Leaves - Senna, Digitalis, Vasaka, Eucalyptus

Barks - Cinchona, Kurichi, Cinnamon, Quaillaia

Woods - Quassia, Sandalwood, Sassafras, Red Sanders

Roots - Rauwolfia, Ipecacuanha, Aconite, Jalap

Rhizomes - Turmeric, Ginger, Valerian, Podophyllum

Flowers - Clove, Pyrethrum, Artemisia, Saffron

Fruits - Coriander, Colocynth, Fennel, Bael

Entire drugs - Ephedra, Ergot, Cantharides, Belladonna

Dried lattices - Opium, Gutta – percha, Papain

Resins and

Resin combinations – Balsam ofTolu, Myrrh, Asafoetida, Benzoin

Dried Juices - Aloes, Kino, Red gum

Gums - Acacia, Tragacanth, Ghatti gum, Guar gum

Dried extracts - Gelatin, Catechu, Agar, Curare

This system of classification is more convenient for practical study especially when the chemical nature of the drug is not clearly understood.

4. Chemical Classification

The crude drugs are divided into different groups according to the chemical nature of their most important constituent. Since the pharmacological activity and therapeutic significance of crude drugs are based on the nature of their chemical constituents, it would appear that chemical classification of crude drugs is the preferred method of study. The crude drugs containing

alkaloids are grouped together, regardless of their morphology and taxonomical relationship. Few examples of the drugs under chemical classification are as follows;

Glycosides	-	Digitalis, Senna, Cascara, Liquorice
Alkaloids	-	Nux-vomica, Ergot, Cinchona, Datura
Tannins	-	Myrobalan, Pale catechu, Ashoka
Volatile oils	-	Peppermint, Clove, Eucalyptus, Garlic
Lipids	-	Castor Oil, Bees wax, Lanolin, Cod liver Oil, Kokum butter
Carbohydrates and Derived Products	-	Acacia, Agar, Guar Gum, Pectin, Honey, Ispaghula
Resins and Resin Combinations	-	Colophony, Jalap, Balsam of Tolu
Vitamins and Hormones	-	Yeast, Shark liver oil, Oxytocin, Insulin
Proteins and Enzymes	-	Casein, Gelatin, Papain, Trypsin

The crude drugs belonging to different morphological or taxonomical categories may be brought together, provided there is some similarity in the chemical nature of active principles.

5. Pharamacological (Therapeutic) Classification

This system of classification involves the grouping of crude drugs according to the pharamacological action of their chief active constituent or their therapeutic uses. Regardless of morphology, taxonomical status or chemical relationship, the drugs are grouped together, provided they exhibit similar pharmacological action. Thus, Cascara, Castor Oil , Senna, Jalap, Colocynth are grouped together as purgatives or laxatives because of their common pharmacological action. Similarly, Gentian, Cinchona, Nux-vomica and Swertia are grouped as bitters. The drugs differing in mechanism of action, but with the same pharmacological effect is grouped together, e.g. bulk-purgatives, irritant purgatives, emollient purgatives, etc. Some of the drugs could be classified under two pharmacological headings, since they exhibit two different actions. For example, cinchona isclassified both as antimalarial and bitter tonic. An outline for pharmacological classification of crude drugs is as follows;

(i) Drugs acting on gastro-intestinal tract

Bitters	-	Gentian, Quassia, Cinchona
Carminatives	-	Dill, Mentha, Cardamom

	Emetics	-	Ipecacuanha
	Anti-amoebics	-	Kurchi, Ipecacuanha
	Bulk laxatives	-	Agar, Ispaghula,Banana
	Purgatives	-	Senna, castor oil,
	Peptic ulcer treatment	-	Derivatives of Glycyrrhetinic Acid (Liquorice), Raw Banna.
(ii)	**Drugs acting on respiratory system**		
	Expectorants	-	Liquorice, Ipecacuanha,Vasaka
	Antiexpectorants	-	Stramonium leaves (Atropine)
	Antitussives	-	Opium (Codeine, Noscapine)
	Bronchodilators	-	Ephedra, Tea (Theophylline)
(iii)	**Drugs acting on cardio-vascular system**		
	Cardiotonics	-	Digitalis,Squill, Strophanthus
	Cardiac depressants	-	Cinchona (quinidine), Veratrum
	Vasco-constrictors	-	Ergot(ergotamine), Ephedra
	Antihypertensives	-	Rauwolfia
(iv)	**Drugs acting on autonomic nervous system**		
	Adrenergics	-	Ephedra
	Cholinergics	-	Physostigma, Pilocarpus
	Anticholinergics	-	Belladonna, Datura
(v)	**Drugs acting on central nervous system**		
	Central analgesics	-	Opium (morphine)
	CNS Stimulants	-	Coffee (Caffeine)
	Analeptics	-	Nux-Vomica, Lobelia, Camphor
	CNS depressants	-	Hyoscyamus, Belladonna, Opium (Morphine, Codeine)
	Hallucinogenics	-	Cannabis, Poppy Latex
(vi)	**Antispasmodics**		
Smooth muscle relaxants		-	Opium (Papaverine), Datura, Hyoscyamus
Skeletal muscle relaxants		-	Curare
(vii)	Anticancer	-	Vinca, Podophyllum, Camptotheca, Taxus
(viii)	Antirheumatics	-	Aconite, Colchicum, Guggul

(ix) Anthelmintics - Quassia, Male Fern, Vidang

(x) Immuno-modulatory agents Ashwagandha, Tulsi, Ginseng, Asparagus, Picrorrhiza kurroa

They modulate immune responses and principally include immunosuppressive agents and also biological response modifiers which act by immuno stimulation.

(xi) Drugs acting on skin and mucous membrane - Olive Oil, Wool fat, Bees wax, Arachis Oil, Sesame Oil, balsam of Tolu, Balsam of peru.

(xii) Astringents - Myrobalan, Black Catechu

(xiii) Antimalarials - Cinchona, Artemisia

(xv) Drugs acting chemotherapeutically - Antibiotics

(xvi) Local anaesthetics - Coca

6. Chemotaxonomic Classification

The expanding knowledge of phytochemical screening has revealed the existence of close relationship between constituents of plants and their taxonomical status. The 'chemotaxonomy' has brought the plant chemist back to systematic botany in view of the fact that certain compounds have been found to characterize certain groupings. Chemotaxonomy establishes a relationship between position of the plant and attempts to utilize chemical facts for more exact understanding of the biological evolution and relationships The characters more loften studied in chemotaxonomy are secondary metabolites of pharmaceutical significance such as alkaloids, glycosides, flavonoids, etc. The knowledge of chemotaxonomy could serve as the basis for the classification of crude drugs. The location of berberine alkaloid in Hydrastis, Berberis and Argemone, distribution of rutin, ranunculaceous alkaloids and flavonoids in species of higher plants are of chemotaxonomical significance. DNA hybridization, amino acid sequencing in proteins and serotaxonomy are also gaining significance in this method of classification.

D) SCHEME FOR PHARMACOGNOSTIC STUDIES OF A CRUDE DRUG

A systematic study of a crude drug under pharmacognostic scheme involves its description on the following lines.

1. Official title, synonyms, or vernacular names, if any
2. Biological source and family
3. Geographical source or habitat
4. History and introduction of crude drug

5. Cultivation, collection, processing for market and commerce in crude drugs
6. Morphological or macroscopical characters
7. Microscopic or histological studies
8. Chemical constituents and qualitative chemical tests
9. Pharmacological actions, therapeutic and other pharmaceutical uses and pharmaceuticals preparations or formulations.
10. Commercial varieties, substitutes and adulterants
11. Quality control of crude drugs and phytopharmaceuticals derived from them.

A crude drug may have official or unofficial status. Unless otherwise indicated, the official title of crude drug is the title by which it appears in the Pharmacopoeia or other official reference books Official titles of the crude drugs are given both in English and Latin. Synonyms are the frequently used alternative terms, identical in sense to the official titles of the crude drugs. This includes common vernacular names for the crude drugs.

The Latin name of the plant or animal with its family is called its botanical or zoological source respectively. Biological source of a crude drug also covers its nature, limits for the active constituents and any relevant information affecting the quality of the crude drug during processing or storage. The nature of the crude drug indicates whether it is in the fresh or dried form, e.g. digitalis consists of dried leaves of Digitalis purpurea (Scrophulariaceae) dried at a temperature below 60^{o}c, immediately after collection and the dried leaves should not contain more than 5%moisture.

The geographical source of a crude drug gives us information regarding the origin of drug, place and the country where the crude drug is produced commercially on a large scale. Cassia angustifolia (Indian senna)is grown in and around Tinnevelley in Tamil Nadu in of India.

The history of a crude drug reveals information about its introduction to mankind. It gives us the information about the knowledge of a crude drug, its original place of growth and its introduction in modern medicine. History of some of the crude drugs like Rauwolfia roots, cinchona bark and opium is very interesting.

The cultivation technology for a crude drug has to be studied systematically with reference to the selection of proper strains of seeds or germplasm, types of soil systems, optimum climatic or ecological factors like light, temperature, rainfall, altitude and other factors like fertilizers, plant growth regulators, etc. the crude drugs are collected from the plants when they

are rich in their active constituent content, which may be affected by the climatic conditions to a considerable extent. Drying of the plant material prior to packaging is necessary to minimize moisture content of a crude drug to protect it from microbial contamination or undesired chemical reaction during storage. The crude drugs can be dried either in sunlight or in shade or by use of artificial heat. In order to maintain high degree of quality in a crude drug, it is necessary to store and preserve it properly. Light adversely affects quality of crude drugs which are highly coloured, whereas excessive moisture favors enzymatic actively and facilitates fungal growth.

The macroscopical or morphological description of a crude drug includes size, shape, nature of outer and inner surfaces, type of fracture and organoleptic characteristics like colour, odour, taste, consistency, etc. The quality of several aromatic drugs like clove and cardamom can be determined by smell.

Microscopical study of an organized drug, either in entire or powdered form, is one of the important aspects of its histological evaluation. The arrangement of tissues in transverse and longitudinal sections and types of cells and cell contents are revealed by suitable histological study of a crude drug with aid of a microscope. Certain microscopical characteristics like stomata, trichomes, calcium oxalate crystals, starch grains, stone cells, fibres, vessels, etc. are important anatomical characteristics of organized drugs. Microscopical evaluation of a crude drug also involves linear measurements, study of surface preparation of leaves, quantitative microscopical aspects and chemo-microscopy.

The utility of a crude drug is due to its therapeutically active constituent. Clove contains volatile oil of which eugenol is the chief constituent. Most of the times, the crude drug also contains several other constituents which are inert therapeutically. For example, caraway and many other umbelliferous fruits contain fixed oil and protein, in addition to the active principle which is volatile oil. Chemical tests are useful for the qualitative chemical evaluation of a crude drug. These tests are either general or specific and are usually performed for identification of the powdered drugs. Crude durgs like Senna, Rhubarb, Cascara, etc, gives positive anthraquinone test. Vitali's test is performed for identification of tropane alkaloids of Solanaceous drugs.

The pharmacological actions of active constituents of crude drugs and their therapeutical or pharmaceutical uses form an integral part of a pharmacognostic scheme. Senna and Cascara are used as purgatives, whereas digitalis and strophanthus are cardiotonics. Rauwolfia is used in the treatment

of high blood pressure and insanity, the actively being mainly because of the reserpine alkaloid. Some crude durgs and phytopharmaceuticals derived from plants are used as pharmaceutical necessities or flavouring and perfumery agents and they are devoid of any significant pharmacological action. For example, acacia and tragacanth are used as emulsifying agents, honey as a sweetening agent, turmeric as a colouring agent and sandalwood oil for perfumes.

The study of different species and varieties of medicinal or aromatic plants is of paramount importance, especially when several closely related varieties are available commercially. In case of senna, Cassia angustifolia and Cassia acutifolia are the official drugs, eventhough several other species of Cassia such as C. obovata, C. auriculata, etc. are wildly grown general allied species of strophanthus kombe are S. hispidus, S. gratus, S. emini, S. sarmentosus, etc. some of which are equally important. The allied drugs of Rauwolfia serpentina are R. vomitoria, R. perakensis, R. canescens, R. micrantha and R. densiflora. The word 'substitute' itself is self-explanatory. Substitutes resemble the genuine drugs to a considerable extent to the genuine drugs in morphological behaviour and type of chemical constituents. Cinnamomum burmanii and C. loureirii are substitutes for C.zeylanicum. digitalis thapsi is used as a substitute for D.purpurea.

Adulteration is debasement of an article and the adulterant resembles the genuine drug with respect to its morphological appearance and organoleptic characteristics. However, it is devoid of the active constituents, which are present in the genuine drug. The adulterantsk of S. nux-vomica suchm as S.nux-blanda and S.potatorum do not contain strychnine. Cassia obovata or Dog senna is an adulterant of Indian senna.

Evaluation of a crude drug means its identification and determination of its purity and quality. Quality control of a crude drug and its pharmaceuticals can be attempted by different methods of evaluation depending upon the morphological and microscopicaly studies of the crude drugs or their physical, chemical and biological behaviour. Systematic identification of crude drugs and their quality assurance form an integral part of drug-description.

INTRODUCTION TO PARTS OF MEDICINAL PLANT

THE CELL

In 1838 Schleiden and Schwann put forward the cell theory stating that plant or animal body is ultimately made up of minute cells and concluded that the cell is the structural unit of life.

The living organisms are two types, either unicellular.

In multicellular organisms the life – actives are performed by co-ordination of several organs, these organs are made up of tissues, while the tissue are aggregates of similar cells. Thus cell is a structural unit of life. While in unicellular organisms all activities are performed by same cell.

The cell has a definite shape of its type with few exceptions like amoeba, leucocytes, etc., various shapes like oval, spherical, polyhedral, columnar, cylindrical, stellate and several others are found in plant as well as in animal cells. Normally the size may vary from 0.5 to 20μ and very exceptionally upto 200-300mm as in case of plant-fibres and latex cells.

They are two of cells. These are:

1. Prokaryotic, 2. Eukaryotic.

Prokaryotic types of cells are characterized by the absence of true nucleus, obviously the nucleolus, nuclear membrane and missing, DNA is without protein sheath and nuclear matter is in direct contact with the cytoplasm. The ribosomes are scattered in the matrix while other organelles and endoplasmic reticulum are missing in prokaryotic cells. Respiratory enzymes and photosynthetic pigments are present. Meiosis and mitosis are not observed in this type of cells.

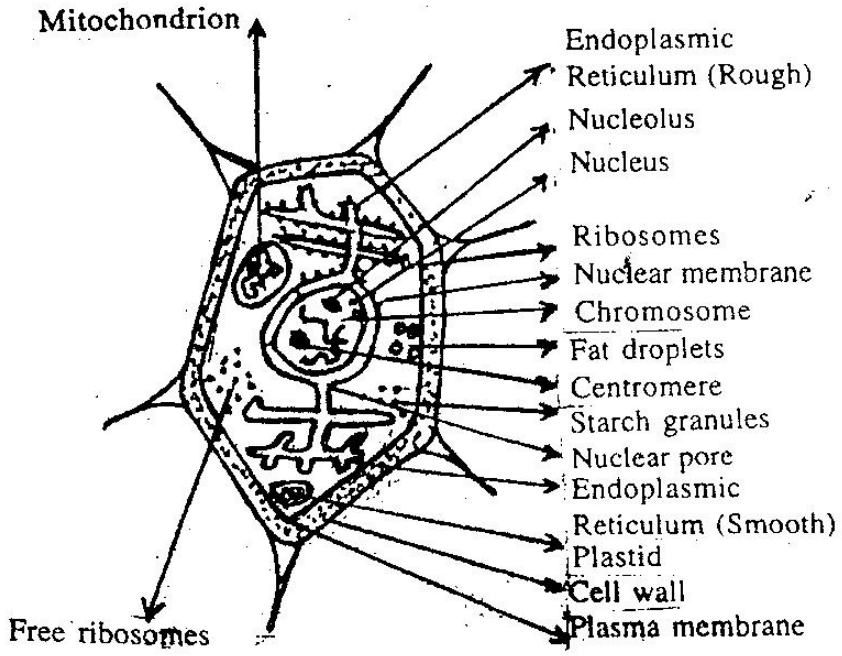


Fig. 2.1 : Typical Plant Cell

Primitive type of organisms like blue-green algae, bacteria, represents this type of cells.

Eukaryotic cells possess well-marked true-nuclear membrane, while DNA is covered with protein sheath. Distinct nucleolus in the nucleus, while plastids and mitochondria are represented in the cytoplasm. The other important and major component of the cytoplasm is endoplasmic reticulum associated with ribosomes. In eukaryotic cells, cell wall is made up of cellulose. Meiosis and mitosis are observed in these type of cells. All plant and animal cells belong to eukaryotic type of cells.

The functions of various organelles of a plant cell are as under.

FUNCTION:

1. **cell wall**:
   - (i) It offers rigid-frame work and protection to protoplast.
   - (ii) Thick and lignified cells of the plant provide mechanical support to the organ.
   - (iii) Checks the rate of transpiration due to cuticular sheath.
   - (iv) Prevents the distention of protoplast by developing wall pressure. Due to various contents like cutin, lignin, wax etc. the cell wall results in permeability which is ultimately responsible for life of cell.

2. **plasma – membrane:**
   - (i) Being selectively permeable controls transport of materials across it.
   - (ii) Permits diffusion of water and fat soluble components. Fat insoluble components pass through the membrane by forming reversible compounds with membrane proteins.

3. **Endoplasmic reticulum:**
   - (i) Due to ribosomes, it is involved in protein synthesis, also in glycogen and fat metabolism.
   - (ii) Gives mechanical support to cytoplasm.
   - (iii) Participate in exchange of materials by active and passive transport.

4. Ribosomes: Degradation and synthesis of proteins takes place in ribosomes.

5. **Golgi complex:**
   - (i) Condensation of lipids, carbohydrates hormones takes place in golgi bodies.

(ii) Participates in formation of lysosomes.

6. **Mitochondria:**

(i) Mainly responsible for transformation of chemical energy into biological energy in the form of ATP compounds.

(ii) All enzymes involved in Kreb's cycle are present in mitochondria. It is also responsible for transmission of hereditary characters (extra-nuclear).

7. **Plastids:**

Play vital role in plant metabolism. Chloroplasts capture solar energy and convert it in chemical energy (photosynthesis).

8. **Nucleus:**

Controls all activities of the cell. Biogenesis of ribosomal proteins take place in nucleolus only, nucleolus takes part in cell division.

9. **Chromosomes:**

These play very important role in heredity, mutation and variation. Chromosomes have capacity of self-reproduction.

Golgi complex is present in all eukaryotic cells except mammalian red blood corpuscles. In plant cells as well as in invertebrate tissues, it is not present as a single body but there are many such organelles scattered throughout the cytoplasm.

Lysosomes are present in animal cells and not in the plant cells. Plastids are the organelles which are only present in plant cells. They are absent in bacteria and blue green algae.

Cell inclusions (Ergastic Substances of Plants)

The non-living substaqnces of plant metabolism are known as ergastic substances. They may be reserve foods, secretory and excretory or products of metabolism.

(a) Reserve foods:

The materials which occur as reserve food in a cell are the carbohydrates, proteins and lipids. They are present in insoluble forms. Their conversion to soluble form is covered by enzymatic processes.

(b) Excretory products:

Animals are able to get rid of their excretory products in liquid or solid form. Plants being unable to do so, their wastes are excreted in the form of insoluble products and are stored inside the cells only. Excretory products of the plants are named as tannins, resins, latex, volatile oils, chemicals like

alkaloids, glycosides and mineral crystals, such as calcium oxalate, calcium carbonate, silica, etc.

(a) Reserve Foods:

(i) Carbohydrates: Many water soluble, as well as, water in-soluble carbohydrates is found in plants. Glucose, fructose and sucrose are all water-soluble. The water-insoluble contents are normally poly-saccharides.

Insulin: It is the only polysaccharide soluble in water and is found in tubers of Dahlia and Dandelion. In alcohol, it forms sphere-crystals.

Starch: It is another polysaccharide mostly found in tubers, food-grains and seeds of the plant. It is found in the form like granules, concentric or eccentric. Starch gives blue colour with dilute solution of iodine.

Cellulose: A complex polysaccharide forming cell wall and is structural material of plants. Mucilage in senna, isapgol, and linseed, forming gummy solution in epidermal cells is another example of polysaccharides.

(ii) proteins: These are the nitrogenous substances either soluble or insoluble in water. They are of great importance in the structure and functioning of living cells. They are produced by and associated with living matter. They may be amorphous or crystalline. In maize, they are amorphous found in the form of layer as aleurone layer or crystalline as aleurone grain in castor seeds. They are converted to amino-acids by proteolytic enzyme.

(iii)Lipids: These are reserves of food materials of plants. Those which are liquid at room temperature are called oils and solids are called as facts. They are made up of fatty acids and glycerin. Oils are found in endosperm of the follwing seeds of Castor, pea-nut, and sesame.

(b) Excretory products:

(i)Alkaloids: These are the basic nitrogenous substances having marked physiological action if taken internally. They occur in plants as salt of nicotinic, quinic citric or oxalic acid. They are found in seeds, breaks, leaves, roots, etc. Alkaloids are used as highly potent medicaments and possess curative properties. They are protective materials of plants discouraging animal or insect attacks. Alkaloids are detoxicating agents of plants and reservoirs for protein synthesis. Examples: Caffeine, Quinine, morphine. In large doses they are poisonous.

(ii)Glycosides: These are the condensation products of sugar and aglycon. Glycosides are secondary metabolites and are also poisonous. These are soluble in water as well as alcohol. Glycosides have got medicinal properties and hence most of them are used therapeutically. Example: Seena, digitalis, bitter almond, etc.

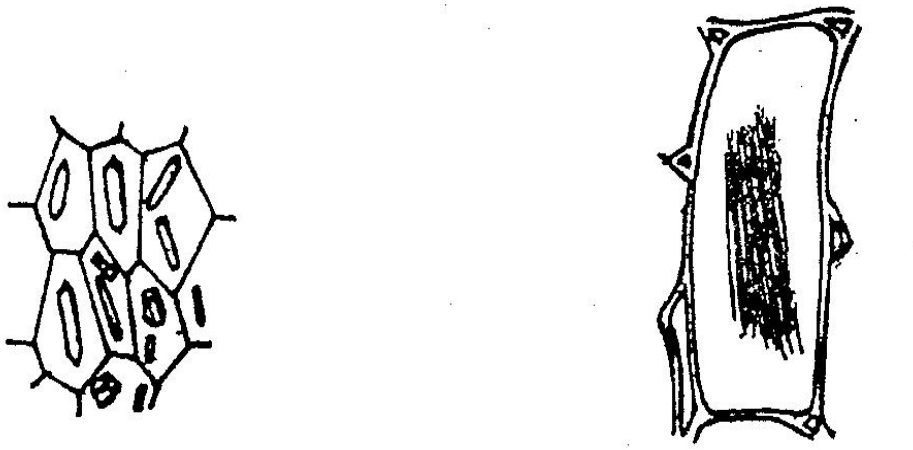
(iii)Tannis: Tannins are present in cell sap, soluble in water and alcohol. They give blue-black or green colour with iron compounds. They have several medicinal properties and hence are used as drugs. Nut-galls, myrobolan are the examples of tannin.

(iv) Resins: These are found in abundance in the trunk of the trees in the resin ducts or in rhizomes (ginger), fruits (capsicum) and other parts of the plants. They are insoluble in water, may be semi-solid. Many times they get associated with gums or volatile oils.

(v) Latex: It is a white suspension wherein microscopically small particles or oil globules are suspended. They contain proteins, sugars, minerals and alkaloidal salts in true solution, while gums, starch, resins are in suspended form. Latex is present in lateciferous tissue characteristic to certain families like Euphorbiaceae, Caricaceae, papaveraceae etc. Banyan, madar, papaya, poppy, ficus are examples.

(vi) Volatile oils: These are the fragrant liquids found in plant. They are volatile, liquid and aromatic and are present in roots, levels, barks, fruits etc., they are insoluble in water and are soluble in alcohol. Normally volatile oils are carminative stimulants and antiseptic. Examples: Orange, lemon, coriander, cinnamon, ginger, eucalyptus and mentha.

(vii) Mineral crystals: These occur in cell-wall or cell cavity. They are all insoluble in water. Common crystals are calcium oxalate, calcium-carbonate and silica. They are found in roots, stems, leaves, fruits, etc. Various types of crystals of calcium oxalate are found like prisms, acicular, raphides, clusters, rosttes etc.



Prismatic crystals Acicular crystals (Raphides)

Types of Calcium Oxalate Crystals

Secretary products

Various other products, not covered under any one of the above type, are formed in the plants and serve some important function in the plants and are the secretory products.

Enzymes, colouring substances, nectar are the examples of this type.

Enzymes are nitrogenous water soluble compounds carrying out hydrolysis of carbohydrates and proteins. Colouring substances or pigments like chlorophyll are essential photosynthesis, anthocyanin and several other, flavonoid glycosides giving attractive colour to various flowers and leaves are the examples of this type.

Nectar is the sugary solution secreted by many flowers in special cell or glands to attract the insects for effective pollination.

CULTIVATTION AND UTILIZATION OF MEDICINAL AND AROMATIC PLANT IN INDIA

The wealth of India is stored in the enormous natural flora which has been gifted to her. Endowed with a wide diversity of agro-climatic conditions, India is virtually herbarium of the world. India possesses all types of climatic conditions varying from temperate in Himalayas to tropical in south India, dry in Central India to humid and wet in Assam and Kerala, thus providing conditions favourable for the growth of a variety of medicinal and aromatic plants provided suitable strains and sites are selected for their commercial cultivation. The composition of soil differs from place to place in India. In the

deltas around rivers in U.P., Bihar and West Bengal alluvial soil is found. In parts of Maharashtra and North Karnataka, black soil is common. This is too heavy and sticky and needs to be lightened. Red soils are good for tree growth, but lack sufficient nutrients for smaller plants. Sandy soils do not retain enough water and need treatment. Because of vast areas and variety of agro-climates in India, a large number of medicinal and aromatic plants are found growing wildly. India, with her varied climatic conditions and topography has been considered as "Botanical Garden of the World" and his botanical wealth constitutes more than 2200 species of medicinal and essential oil containing plants.

The importance of medicinal and aromatic crops in the national economy and their potential for the rapid growth of phytopharmaceuticals, perfumery and allied industries in India has been emphasized from time to time. It is felt by experts that the drugs of natural origin with their wide range of action shall play an important role in health care particularly in the rural areas of India. There exist today over 2000 registered manufacturers of these drugs in the country. The production of only the organized sector in India is currently to the tune of over Rs. 800 crores and the figure for Ayurvedic drugs is estimated to be not less than Rs. 2000 crores per annum by 2000 A.D. In order to ensure this projection, it is necessary that more and more medicinal and aromatic crops be commercially cultivated as field crops. At present, bulk of the raw material is obtained from wild sources, whereas only a few are under systematic cultivation.

[A] CULTIVATION OF MEDICINAL AND AROMATIC PLANTS IN INDIA

Peri-Winkle (Catharanthus roseus) is cultivated in about 3000 hectares of land mainly in Tamil Nadu, Maharashtra, Karnataka and Andhra Pradesh. The yield of the roots per acre is approximately 250 Kg to 500 Kg depending on the nature of soil and amount of irrigation provided.

Cinchona plants were first cultivated in the Nilgiri Hills in 1860. Four species of cinchona have been commercially introduced as plantation crops in Nilgiris and Darjeeling. The total area under Cinchona plantation in India is approximately 4500 hectares. The Governments of West Bengal and Tamil Nadu own Cinchona plantations and factories in India. The West Bengal factory is located at Mungpoo and the Tamil Nadu factory is in Anamalai hills.

The plant, Zedory (Curcuma Zedoria), occurs in the eastern Himalayas and in the deciduous forests of the coastal tract of Karnataka. It is widely cultivated in many parts of India and is propagated by tubers.

Dioscorea deltoidea is grown for its tubers throughout Himalayas at altitudes of 1000 – 3000 metres. It is fairly common in Jammu and Kashmir, Himachal Pradesh and part of Uttar Pradesh. The depletion of natural forests has reflected in the high prices the drug companies have to pay since 1972 for the collection of tubers. In view of this, a number of drug companies like Cipla, Ciba, searle and Wyeth have taken up the cultivation of other species of Dioscorea, especially D.floribunda and D.composita around Bangalore and other places. A new composite clone of D.floribunda has been released for commercial cultivation by the India Horticultral Research Institute, (Bangalore) and it is now grown in Karnataka, Goa and Tamil Nadu

Isabgol (Plantago ovata) is an irrigated rabi crop cultivated in light sandy-loam soil in approximately 35,000 hectares land mainly in Banaskantha and Mehsanna districts of Grjarat and to lesser extent in pali, lalore and Sirohi districts of Rajasthan Castor oil is procured from seeds of Ricinus communis grown in Gujarat, Andhra prades and Tamil Nadu.

Despite its wide geographical distribution and edaphic tolerance, Rauwolfia serpentina, has not lent itself to easy cultivation due to various factors. The cultivation of R.serpentina is restricted to small scattered locations in Maharashtra and Madhya Pradesh. At Dehra dun, intensive cultivation is being done by one of the private pharmaceutical companies. The commercial supply of the roots is mostly from the wild source.

About 0.6 million hectares of land is under cultivation of castor crop while rape seed oil is cultivated in about 3.5 million hectares of land which accounts for 30% of the land which accounts for 30% of the total world production.

Solanum khasianum is cultivated for its berries on a commercial scale in Andhra Pradesh, Karnataka, Maharashtra and Gujarat. Extensive breeding and selection work on this crop have resulted in the development of several improved strains including the spineless variety. The commercial production of solasodine is undertaken near Yeola and Jalgaon in khandesh region of Maharashtra.

Lpecacuanha (Cephaelis ipecacuanha) is mainly cultivated in Darjeeling in West Bengal. Currently, the cultivation of lpecae is monopoly of the Government of West Bengal. The drug is also cultivated on a small scale in Sikkim and Assam.

Indian senna (Cassia angustifolia) is commercially cultivated in Tinnivelley, Madurai and Ramanathapuram districts of Tamil Nadu. The cultivation is also reported on small scale in cudappa district of Andhra

Pradesh. When grown for leaves alone under irrigated conditions, the yield obtained is 300 Kg of dry leaves and 50 Kg of dry pods per hectare.

The annual indigenous production of Neem and Mahua oils is 3 lakh tones and 50 thousand tones respectively.

Poppy plant (Papaver somniferum) is commercially cultivated in about 60,000 hectares in eleven districts of Madhya Pradesh, Uttar pradesh and Rajashthan. The yield of opium per hectare is approximately 30 Kg. Poppy cultivation, opium processing marketing is controlled by the Narcotic Commissioner of India. The commercial cultivation of India Hemp under Government Vigilance is carried out in MP., U.P., Bihar and Kashmir. The efforts to introduce the non-narcotic plant Papaver bracteatum have not been not succrssful so far.

One of the important items of export, covering approximately 80% of world requirement, is a proteolytic enzyme – papain, mainly manufactured in Maharashtra from raw papaya fruits. The commercial kproduction kof kpectin from the thalamus of Sun-flower is also carried out at jalgaon in Maharashtra.

India is one of the few countries in the world where the essential oil industry was developed at a very early stage. The essential oils, perfumes and flavours have been associated with the Indian civilization for several thousand years. Because of her vast area and a variety of soil and climate, essential oil bearing plants of all types can be grown in one or the other areas of the country.

Mentha arvensis subsp, haplocalyxvar.piperascens (Japanese mint) is being cultivated commercially in the districts of Kashipur, Ramopur and Moradabad in Uttar Pradesh. It has been recently introduced in Punjab, Haryana, Madhya Pradesh, Orissa and Maharashtra. Mentha piperita (peppermint) was first introduced by the Regional Research laboratory, Jammu in 1954. It has been found that the plant can be successfully cultivated in the hills of Kashmir, Himachal Pradesh and Kumaon (Uttar Pradesh). Mentha citrasta (bergamot mint) is commercially cultivated in the submountainous terrains of Uttar Pradesh and Jammu and Kashmir.

As a result of agrotechnology developed by the Central Institute of Medicinal and Aromatic Plants Lucknow and Regional the Research Laboratory, Jorhat, Cymbopogon winterianus (java citronella) is a now being commercially cultivated in the states of Assam, Uttar Pradesh, West Bengal, Karnataka, Tamil Nadu and Maharashtran where about 800 tonnes of oil is being produced annually for the last few years. The oil of lemon grass is obtained from two species of Cymbopogon viz.c.flexuosus and c.citrates. The oil of palmarosa isk obtained from Cymbopogon martini in wild condition

from the states of Madhya Pradesh, Maharashtra, Karnataka and Andhrak Pradesh.

Pelargonium graveolens (geranium) is being cultivated in South India at yercaud in the Shevaroy Hills, in Cinchona plantations at Nilgiris and in the Annamalis at an altitude of 975 – 2075 metres, covering an area of about 250 hectares and producingabout 5 tonnes of volatile oil annually.

Eucalyptus citriodora, the source of eucalyptus oil, is commercially grown in the states of Tamil Nadu, Karnataka and Kerala. The linaloe oil is obtained by distillation of the husk of the barriers of Bursera deplechiana. The plant is indigenous to Mexico and it was first introduced at Talaganj near Bangtalore in 1920 by Mr. Roerich and the linaloe estate was established. The plant of kpogostemon cablin, yielding oil of patchouli is a native of Malaysia and Indonesia. Recently, it has been introduced in the tea gardens of Assam.

Cinnamomum zeylanicum is grown in the evergreen forests of the western ghats of onan south to Tirunelveli at low altitudes. The cultivation of the plant is confined to the lower elevation of Eastern Ghats in Cannanore, Calicut and Kottayam districts of Kerala and the lower hills of Nilgiris in Tamil Nadu.

The cultivation seeds producing variety of Vetiversa zizanioides is grown in Kerala and Tamil Nadu and the roots of this plant are used for the extraction of vetiver oil. Coriandrum sativum is grown commercially in the states of Madhya Pradesh, Tamil Nadu, Maharashtra, Andhra Pradesh and Rajasthan. A number of species of jasminum are cultivated in India for their fragrant and ornamental flowers of which Jasminum officinale var. grandiflorum is the source of Jasmine perfume. Aligarh, Kannauj, Jaunpur, Sikandarpur and Ghazipur are the main jasmine producing areas in the northern parts of India.

The sandal wood tree (Santalum album) is the source for commercial production of sandal wood oil which is called as the liquid gold of Karnataka. It is grown commercially in states of Karnataka, Tamil Nadu and the boarders of Kerala and Andhra Pradesh in Karnataka state, the bulk of sandal trees occur in open jungles. In Tamil Nadu, trees are naturally grown in districts of Nilgiri, Combatore, Salem and Vellore. The sandal wood trees are also found in the Kurnool and Cudappa districts of Andhra Pradesh.

The commercial cultivation of pepper, ginger, cardamom, cocoa, cinnamon, and areca nut is carried out in the state of Kerala. The head quarter of Hindustan Cocoa Products Limited is located at Chundale in the Wynad district of Kerala. There are separate boards established by the Ministry of Commerce, Government of India for spices, tea and coffee. The Govt. of India

has recently announced establishment of independent Board for Medicinal plants. The cultivation of garlic in different parts of the country for its utilization in extraction of volatile oil has achieved commercial significance in recent years.

India also produces vol.oil from commercially grown plants. Appreciable quantities of volatile oils such as ajowan oil, calamus oil, cardamom oil, celery seed oil, cedarwood oil, davana oil, dill oil, lemon grass oil, ginger oil, lime oil and turpentine oil. The annual production of coriander is about 2,43,000 tonnes, which constitutes approximately 60% of world demand. About 30% of the global demand in cardamom and 10% in saffron is met by India. The annual production of saffron in Kashmir is approximately 50 tonnes.

[B] INDIAN TRADE IN MEDICINAL ANDAROMATIC PLANTS

The export of medicinal plants and herbs from India has been quite substantial in the last few years. India has been the major supplier of medicinal plants in the world market till 1976 when it was relegated to the second position by South Korea. With exports worth only Rs. 15 crores during 1978-77, when India exported medicinal plants worth of Rs. 29 crores. During 1988-89, India exported crude drugs alone to the tune of about 62 crores. The items of export value are opium, psyllium husks and seeds, vinca rosea, kuth roots, nux-vomica, galanga and senna leaves and pods. India is the second largest producer of castor seeds in the world, producing about 1, 25,000 tonnes per annum.

With development of phytochemical industry in India, domestic requirements for various medicinal plants grew considerably. Consequently, the government of India has adopted restrictive export policy in respect of those crude drugs which were indiscriminately exploited in the forests. In accordance with the policy, the exports of rauwolfia, podophyllum, Indian rhubarb, dioscorea, saussurea, etc., from India were restricted. The exports of these drugs are, however, permitted by firms obtaining certificates from the Chief Conservator of Forests or officer authorized by him that the material is of plantation or nursery origin.

Medicinal and Aromatic Plants and Their Phytochemical Exported from India

1. Seed husk and seed of lsabgol (Plantago ovate)
2. Opium alkaloids (Papaver somniferum)
3. Leaves, pods and total sennoside concentrate of Senna (Cassia angustifolia)

4. Root and root alkaloids of Periwinkle (Catharanthus roseus).
5. Quinine and quinidine alkaloids (Cinchona officinalis and allied species)
6. Ipecac root alkaloids (Cephaelis ipecacuanha)
7. Solasodine (berries of Solanum viarum)
8. Diosgenin/16 DPA (Dioscorea floribunds and allied species)
9. Menthol and mint oil (Mentha arvensis)
10. Celery seed (Apium graveolens)
11. Citral and ionones from oil of lemon grass (Cymbopogon flexuosus)
12. Gudmar herb (Gymnema sylvestre)
13. Kuth root and essential oil (Saussurea lappa)
14. Mehdi leaves (Lawsonia alba)
15. Sindura fruits (Bixa orelana)
16. papain (Carcia papaya)
17. Podophyllum (Podiphyllum nexandrum)
18. Rauwolfia (Rauwolfia serpentina)
19. Valerian (Valeriana wallichii)
20. Cassia tora.
21. Guar gum (Cyamopsis tetragonolobus)
22. Gudmar (Gymnema sylvestre)

The essential oils are also exported regularly:

1. Jasmine otto and absolute (Aquillaria agallocha)
2. Agar wood oil (Aquillaria agallocha)
3. Sandal wood oil (Santalum album)

Medicinal Plants and their phytochemicals, (including adaptogens* and allied materials) imported in India

Very few medicinal plants are imported in the country. Further, except items 1,2,3 and 4 the amount involved is not very large.

1. Liquorice roots (Glycyrrhiza glabra)
2. Asafoetida (Ferula asafetida)
3. Chirayata herb (Swertia chirata)
4. Gum-arabic (Acacia arabica)
5. Gum-guggal (Commiphora weightii)

6. Pipali Root/unripe fruits (Piper longum)
7. Unnab fruits (Zizyphus sativa)
8. Akarkaara root (anacyclus pyrethrum)
9. Asaroon herb (Asarum europaeum)
10. Ustakkoddus (Lavendula stoeches)
11. Red sage (Salvia officinalis)
12. Scamonia (Convolvulus scamonia)
13. Gaj pimpli (Scindapus officinalis)
14. Kankol (Piper cubeba)
15. Chopchini (Smilax china)
16. Maiphal (Quircus infectoria)
17. Clove (Engenia caryophyllus)
18. Nutmeg mace (myristica fragrance)
19. Kapurchini (Hedychium spicatum)
20. Patang (Caesalpinia sappan)

Three essential oils are also imported regularly:

1. Oil of Geranium (Pelargonuum graveolens)
2. Oil of Patchouli (Pogostemon patchouli)
3. Oil of clove (Eugenia caryophyllus)

***Adaptogens:** these are biologically active substances which improve physical endurance for doing work even in adverse and difficult environmental conditions.

Adaptogens increase tolerance to change in environmental conditions and also resistance to noxious stimuli, like exposure to cold, heat, pain and infections organisms. Such health food supplements arrest aging processes and age induced deterioration in physical and mental performance i.e,Ginseng Gingko, Withania etc.

India's export of essential oil during last few years has shown an erratic trend. The U.S.A. accounted for a major share of exports followed by U.S.S.R. India is also exporting volatile oils to France, Japan, Sudan, Germany and Switzerland. The principal items of imports into India are clove oil, geranium oil, lavender oil and patchouli oil.

Some of the pharmaceutical units engaged in extraction and utilization of biomedicinal in India are Government Optium factories at Ghaziabad (U.P.) and Neemauch (M.P.); Amsar pvt,ltd., indore (M.P); Government factory for extration of kCinchona alkaloids at Mungapoo (West Bengal); Maharashtra

Fisheries Development Corporation ltd., Mumbai for production of shark liver oil; Jain Plastics and chemicals ltd., at jalgaon for production of papain, calcium caseinate and other spray dried products, Kothari Phytochemicals Ltd., at Madurai and Madras; INGA Laboratories Lltd., Mumbai; CIPLA at Bangalore and Mumbai; Cadila Laboratories Ltd., Ghaziabad (U.P); Hamdard Laboratories, Delhi, Himalaya Drug House at Mumbai: Wockhardt Ltd., Aurangabad; Glaxo (India) ltd., Mumbai organonltd., Calcutta; Sandoz (India)Ltd., mumbai, Dhutpapeshwar at Panvel, Boeringher Knoll, Mumbai; Enzochem laboratories at Yeola in Maharashtra; Hindustan Cocoa Products Ltd., at Chundale in Kerala; Cellulose products of India, Ahmedabad; Ranbaxy laboratories Delhi; Lupin, Mumbai, Anil Starch Products, Ahmedabad and Protein products of India, Cochin.

The Volatile oils, aromatic chemicals and related compounds are being manufactured by the Government Sandal oil Factory, Mysore; S.H. Kelkar and Co. pvt. Ltd., Mumbai; Meghalaya phytochemicals in West Bengal; Camphor and Allied Products Ltd., Barelly; procter and Gamble (India) Ltd., Mumbai; Naarden Chemical Works ltd., Mumbai; Ashok Thymol Factory, Indore; Royal Eucalyptus Oil Ltd., Nilgiris; Bhavana Chemicals Ltd., Baroda; lupiter Eucalyptus Oil Refinery, Nilgiris; Tata Oil Mills Co.Ltd., Tatapuram; Jammu Rosin and Turpentine Factory at Miransahib in Kashmir and Himachal Rosin and Turpentine factory at Nahan in H.P.

Some of the manufactures of biological products are Hindustan Antibiotics Ltd., Pimpri; I.D.P.L, Rishikesh; haffkine Biopharmaceutical Corporation Ltd., Mumbai; Central Research Institute, Kasauli; Serum Institute of India ltd., Pune and Biolobial E.Ltd. Hyderabad.

The research and development in the field of medicinal and aromatic plants has acquired considerable importance in India. The government organization such as Council for Scientific and Industrial Research and Indian Council of Agricultural Research have already made significant progress in the cultivation technology of medicinal and aromatic plants. Significant contributions in the field of cultivation and/or utilization of natural medicinal agents have been made by Regional Research Laboratories at Jammu, Jorhat and Bhubaneshwar; Central Institute for Medicinal and Aromatic Plants, Lucknow National Chemical Laboratories, Pune; National Bureau of Plant Genetic Resources and I.C.A.R.,New Delhi; Central Drug Research Institute, Lucknow; Forest Research institute Dehradun; CHEMEXCIL, Mumbai, CIBA research center, Goregaon Mumbai; Hoeschst Research Centre Mumbai and number of other agencies ink public and private sectors. The Indian research and development efforts are being directed to utilize new scientific discoveries

as quickly as possible towards reducing the time lag between such discoveries and their applications in the field of medicinal and aromatic plants.

Endangered medicinal Plants

Many plants have been described in various authoritative texts of Indian System of medicine (Ayurveda) for their valuable medicinal activities. Over the years and centuries, they have been procured only from wild sources. Unfortunately, due to lack of application of scientific measures for their systematic cultivation, as well as unscientific over exploitation from nature, few plants are now-a-days on the verge of becoming extinct. Some of them have duly identified by Govt. of India as endangered plants.

Unscientific exploitation and ignorance about their life-cycle has consequently led to decline of such plants. About 40 plants have been declared as endangered.

Some of these plants are:

(i) Belladonna (Atropa acuminata)

(ii) Dhoop (Jurenia macrocephala)

(iii) Bhojpatra (Betula utilis)

(iv) Kalazira (Carum carvi)

(v) Kapur kachri (Hedychium acuminatum)

(vi) Tejbal (Xanthoxylum alatum)

(vii) Tejpatra (Cinnamomum tamala)

For preservation of endangered plants, action-plan has been prepared by Govt. of India, for which World Bank has indicated an assistance.

The objectives of this plan include:

1. Harnessing the plant wealth in view of promoting the industries for production of phytochemicals, medicines, volatile oils and cosmetics.
2. Identification of commercially viable species in various agro-climatic zones.
3. Standardization of such agro-practices in view of their cultivation and, in turn, preservation.
4. Measures to boost up the research and development for the purpose of involving new herbal products and technology for the purpose of their manufacture.

MEDICINAL PLANTS PROHIBITED TO EXPORT FROM INDIA

Ministry of commerce Govt. of India, New Delhi has prohibited the export following medicinal plants, plant portions, their derivatives and extracts obtained from wild sources, since October 1998.

1. Cycas beddomei (Beddomes cycad)
2. Vanda coerulea (Blue vanda)
3. Saussurea costus
4. Paphiopedilum species (Ladies slipper or chids)
5. Nepenthaes khasiana (Pitcher plant)
6. Renathera imscootiana (Red vanda)
7. Rauwolfia serpentina
8. Dioscorea deltoida
9. Prodophyllum hexandrum
10. Euphorbia species
11. Orchidaceae species
12. Pterocarpus santalinus (Red –sanders)
13. Taxus wallichiana(Yew)
14. Aconitum species
15. Gentiana kurrooa
16. Swertia chirata
17. Picrorhiza kurrooa
18. Gnetum species
19. Panax pseudo-ginseng
20. Aquilaria malaccensis
21. Cyatheaceae species
22. Frerea indica
23. Cycadaceae species
24. Dactylorhiza hatagirea
25. coptis teeta
26. Coscinium fenestraum
27. Kamphergia galenga
28. Ceropegia species

MEDICINAL PLANT BIOTECHNOLOGY

[A] GENETICS AS APPLIED TO MEDICINAL HERBS

George Johann Mendel in 1885 showed that certain hereditary factors operate in all biological species. The Danish biologist Wilhelm Johannesen called these factors as Genes. It is now known that the genes not only transmit hereditary characters, but also mastermind the entire process of life.

The genes are located in chromosomes which are themselves situated in the nucleus of the cell. It can be said that the genes form the riddle and the chromosomes represent the mystery. Much of the mystery surrounding the genes was cleared up with the discovery of the structure of the DNA announced by J.D. Watson and Francis Crick in April 1953. The structure of the DNA resembles a long rope ladder twisted around like a corkscrew. The two sides of the ladder are long chains of sugars and phosphates in repeated sequences. DNA contains the bases like adenine (A), cytosine (C), thymine (T) and guanine (G). A will form a bridge only with T and C with G. So the pairs, A-T, T-A, C-G and G-C form in a way a four letter alphabet with which messages can be spelt out. It makes up what is known as the genetic code which is not only complex but also extensive. In 1977, Fred Sangar pointed out that the DNA code of a virus, when decoded by computer came to a print out of 15 meters.

The genes control all functions of cell and body growth. The two main events in the life of most cells are multiplication (by division) and synthesis of proteins. Both these operations are carried out on the basis of blue prints coded in the genes.

Genetics has made valuable contribution to the improvement of plants having economic, medicinal and ornamental value, by applying various techniques, like selective breeding. It has important role in mitosis and meiosis of the cells. Mitosis results in precise equal distribution of chromosomes from a parent nucleus to the daughter nuclei. Further it maintains equilibrium in the amount of DNA contents of cells. The phenomenon of mitosis is associated with vegetative propagation of plants. The somatic number is the number of chromosomes in plant cell nucleus which in normal conditions remains constant, but varies with different species. Meiosis occurs in case of formation of reproductive cells (gametes or meiospores) in sexually reproducing species. Meiosis has also a genetic significance because of formation of four haploid nuclei from a single diploid one, in two successive divisions, thus balancing the doubling of chromosome number that results from fertilization. During the process of meiosis, the crossing over provides new combination of genetically

substance and hence, new combination of characters in offspring's. The process of segregation of chromosomes also occurs in meiosis.

The advances in techniques pertaining to genetic manipulation in plant cells have made much impact to improve yield of medicinal plants.

Mutation

Mutation is represented as variation in characters of the species. It is caused either due to environmental changes or changes in hereditary constitution. Normally, as a response to environmental changes, the variations are observed, but the original traits are restored when changes in environment are also withdrawn or disappeared. This type of change and re-storage is not heritable and also not built into genotype. They are termed only as phenotypic variations and commonly called as modifications. It is evident that between organisms of similar genotype there are phenotypic variations. But when a change occurs in the genome of an individual, which is not caused due to environment, it may make a permanent evolutionary change. This is termed as mutation and represents a sudden change in genotype causing qualitative or quantitative alterations of genetic material. Mutations are again distinguished into two type's viz. chromosomal mutations and point mutation. The former type of mutation is also called chromosomal aberration, which in many cases leads to changes in amount or position of genetic material. On the other land, the change with a gene or cistron of DNA molecule cause point mutations and it is permanent and heritable.

Mutation which occurs due to some unknown reason from nature is called as spontaneous mutation. This has been observed in some plants, bacteria, viruses, etc., Mutation can also be induced by artificial means with certain reagents called mutagens and are called induced mutations. The various mutagens used are exposure to UV rays, X-rays, ionizing radiations, certain chemicals, abnormal environment etc., The chemical mutagens used are nitrogen mustard, formaldehyde, nitrous acid, ethyl ethane sulphonate, 5-bromouracil, 2-aminopurine, manganese chloride, etc.

The changes caused due to mutations include morphological and anatomical changes, as well as, changes in the chemical composition of the plants. This is significant for the medicinal plants. In some cases, favourable changes and yields in active constituents of plants have been achieved. Mutations may cause building the resistance of a medicinal plant towards certain disease. But, in all these cases, the plant may become susceptible to climatic conditions, certain other diseases, retardation in growth, etc., These undesirable effects are to be eliminated by breeding and selection.

Polyploidy

Polyploidy has exhibited various useful effects on medicinal plants like digitalis, mentha species poppy, plants containing tropane alkaloids, lobelia, etc. The specific number of chromosomes is a character of each species and is called genome which is observed in all types of organism. The term euploidy is a type of ploids in which genome contain whole set of chromosomes and euploidy includesmohoploidly, diploidy and polyploidy. When the organism contains more then two genomes, it is called polyploidy. The polyploidy occurs in a multiple series of 3,4,5,6,7,8 etc. of the basic chromosome or genome number and then accordingly, it is called triploidy, tetraploidy, pentaploidy, hexaploidy. Heptaploidy and octaploidy respectively.

Polyploidy is caused through cell generation, physical agents like X-ratys, centrifugation, temperature chocks and chemical agents, mainly colchicines, veratrine, sulphanilamide, hexachloro cyclohexane, and mercuric chloride. The chemical agents cause disturbance to mitotic spindle of dividing diploid cell and cause non-segregation of already duplicated chromosome and thus, convert diploids into tetraploid cells. The phenomenon of polyploidy is of greater significance to medicinal plants. It may cause formation of new species, adaptability to various habitats and mainly accumulation of vitamins.

Perhaps, the best known chemical to cause polyploidy is colchicines, an alkaloid obtained from Colchicum species like Colchicum autumnale, C.luteum and C.speciosum. Colchicine prevents sister chromatids from separating into daughter nuclei at anaphase. These chromatids remain attached by their common centromere in C-metaphase. The chromatids eventually separate, but remain in the same nucleus. An interphase occours, followed by a second C-metaphase, involving a doubled chromosome complement. Hence, the chromatid pairs are doubled in second C-metaphages. Likewise , the cell undergoes one, two or more than two rounds of DNA replication and causes polyploidy. The colchicine activity mentioned here is caused due to its interaction with disulphide bonds of spindle protein and by inhibition of conversion of globular protins to fibrous proteins. The capacity of colchicine to Induce polyploidy various alongwith its different derivatives. Chemically induced mutaions may lead to variations in biochemical composition of plant. Colchicine treatment given to medicinal plants has showen promising results in many cases. The observations in tropane alkaloids by way of polyploid are more specific in stramonium, where yield of crop is enhanced by 60 – 150 pr cent in 4 n form. The plants like lobelia, cinchona, belladonna, acorus, squill, and cannabis, poppy also show increased yield of respective compounds in 4 n forms. Polyploidy may cause a reduction of total glycosides of D.purpurea and

D.lanata, but in the later cases raises slightly the contents of lanatosides A and B. The increase in chemical contents may not be coincidental with phenotype of medicinal plant. There may be reduction in size also alongwith enhancement in content of active constituents. Some plants do not show any change in chemical contents as a response to polyploid.

Chemodemes (Chemical Races)

The knowledge about plant chemical races has surfaced due to thorough chemical analysis of a hunge number of different plants with the help of modern analytical instruments. Chemodemes are regarded as a group of plant of a species which have identical morphological characters, but differ in their chemical nature. Due to this chemodemes are considered as chemically separate groups within species. The observation of chemodemes can be confirmed only by growing different plants of a species in identical conditions, preferably from the seeds and for many generations. By this way, it shows variations either in type or contents of certain constituents, like the secondary metabolites of medicinal importance. The chemical characters of chemodemes are hereditary.

Chemical races have been reported in Digitals purpurea and Digitalis lanata. In the iormer, the races or strains identified are streptoside, digitoxin and digipurpurin. These chemical races in D. purpurea yield different proportions of glycosides obtained from digitoxin and gitoxin. Depending on content of lanatosides A and C the chemical races in D. lanata are D.Ianata Ehrh, chemovarieties A and C. The chemodemes in Rheum palmatum are also known, which give differing values for rhein chrysophanol ratio. The different varieties of Prunus communis (almond) differ by presence or absence of amygdalin. Chemicall raqces have also been reported in Claviceps purpurea, Duboisia myoporoides, and Duboisia leichharditii. Threechemotypes are evident in Withania somnifera. Chemotype contains mainly, withaferin; chemotype II has similar compounds,compounds, and chemotype III contains withanolides (a mixture of steroidal lactones). Withaferin and withanolides have different medicinalactions.

The plants like Cinnamomum zeylanicum, Ocimum menthaefolium, Cinnamomum camphora, Eucalyptus dives, and ocimum sanctum all of which contain volatile oil have chemical races, with varied content of aromatic constituents.

The discovery of chemodemes has enabled the pharmacognosists to select high yielding chemical strains or to eliminate chemical strains which contain toxic principles. The chemodemes are induced by breeding in some

species, so as to manipulate active constituents, with a view to enhance the therapeutic efficacy.

ARTIFICAL MUTATION

The artificial mutations are those which are induced artificially in the living organism by exposing them to abnormal environment, such as radiations, certain physical conditions, like temperature and chemicals, all of which are called mutagens of mutagenic agents.

(1) Radiation mutations: The electromagnetic waves of short wavelength (ultra violet light, X-rays, gamma-rays, alpha and beta rays) are radiation mutagens. The X-rays and gamma rays are called ionizing radiations, and also include alpha particles, beta rays, thermal and fast neutrons. Due to ionizing radiations, in many cases, water molecule in a biological system releases one electron and becomes unstable and eventually splits into hydropgen ion and; hydroxy radical. Hydrogen ion reacts with O_2 and produces hydroperoxyl (HO2) radical. Both these radicals viz. hydroperoxyl and hydroxy are potent oxidizing agents. When chromosomes and their DNA are struck by such radicals, they react due to which sugar-phosphate part of DNA may be impaired leading to chromosomal mutations, like breaks, deletions, additions, inversions and translocations.

Some chemical mutagens, like nitrogen mustard, formaldehydes, nitrous acid and ethyl ethane sulphonate alter chemical constitution of DNA bases and cause transitional substitution in DNA. But some compounds like 2-aminopurine, urethane, 5-bromouracil, caffeine, triazine, phenol and certain other carciogens act as a base analogue and bring out copy error mutations in DNA. In general, the chemical mutagens have profound cellular effects like production of abnormal DNA (nitrogen mustard), inhibition of deoxyribonucleotide synthesis (deoxyadenosine), and inhibitaion of cytochrome oxidase with resultant peroxide formation (inorganic cyanides).

Theartificial production of mutations in medicinal plants is an important milestone in the development of cultivation technology.

The higher solasodine content is achieved by applying radiation and chemicalmutagens in Solanum khasianum. It is also reported that chemical mutagens have a successful use in increasing morphine content of Papaver somniferum. The tuber yield and diosgenin content of Dioscorea bulbifera is increased by radiation. The economically important characters of Atropa belladonna have been enhanced by radiations and chemical mutagens. The agronomic performance and harvest index of Mentha arvensis var. piperascens (Japanese mint) have been improved by exposure to gamma radiations. The effects of artificial mutations have been extensivelystudied on different species

of mentha. The capsicum seeds (Capsicum annuum) treated with sodium azide and ethyl methane sulphonate have ledto plants giving higher contents of capsaicin.

HYBRIDIZATION

The process through which hybrids are produced is called hybridization. A hybrid is an organism which results from crossing of two species or varieties differing at least in one set of characters. The resultant hybrids are monohybrids (one pair of different characters), dihybrids (two pairs of different characters) or polyhybrid (more than 2 pairs of different characters). Hybridization helps in inducing new and favourable characters which are not present in both the parents.

The hybridization of Withania somnifer Israeli Chemotype II and W. somnifera South African chemotype has led to formation of a new hybrid which contains 3 new withanolides. The hybrids like Digitalis purpurea X D. lanata and D.purpurea x D. lutea contain principal glycoside as lanatoside A, along with lanatosides B and E, but devoid of lanatoside C or purpurea glycoside A. During the cross of Solamum incanum (1.8 per cent solasodine) and S.melongena (traces of solasodine), first generation bears more fruits (berries) with solasodine upto 0.5 per cent. Second generation has proved to be a high yielding source for solasodine.

A recent development in hybridization is through the medium of tissue culture. The protoplast cultures are employed for this purpose. Plant protoplasts are the cells without cell walls. Such protoplasts in cultures can be fused together (protoplast fusion or asexual hybridization). The fusion can be arranged in cells of same origin or between different species.

GENETIC ENGINEERING AND RECOMBINANT DNA TECHNOLOGY

In recent years, these techniques have taken greater strides in the field of drugs and pharmaceuticals. The method of artificial synthesis of new genes and their subsequent transplantation in the genome of an organism or the method of correcting-defective genes of organism by molecular biological techniques form the discipline called genetic engineering.

Recombinant DNA technology involves gene splitting, so as to change characters of plants and animals by implanting in them genes from other organisms and, in some cases, even from other species.

The genetically engineered products which already exist in market are human growth hormone, human insulin, a-interferon and hepatitis – B vaccine and the products coming in next few years are as follows:

1. Interliukin –2, to fight certain types of cancer
2. Beta – endorphins, for treatment of pains
3. TPA – tissue plasminogen activator for treating heart attack
4. Somatostatin for treatment of pituitary diseases
5. Erythropoietin or EPO designed for treating anaemia in patients undergoing kidney dialysis.

The Secondary metabolites from plants, which are expected to give promising results by genetic engineering include

1 Cardiac glycosides
2 Morphine alkaloids
3 Stigmasterol or diosgenin which give steroid hormones and corticosteroids

In respect of such plants, the transfer of entire biosynthesis route to bacteria by gene-technology method is expected to yield economic processes.

Transgenic plants

Application of genetic engineering techniques for the improvement of plants is fast developing area of research. The advent of modern techniques of modern techniques of genetic modification has enabled to remove individual genes from one species and insert them into another, without the need for sexual compatibility. Once the new gene has been inserted into the plant, offspring that will contain the copies of the new gene can be produced in the traditional manner.

Transgenic plants carry the stably integrated foreign genes. It is important that the new DNA remains stable and can pass the new gene to its offspring as well. The introduction of foreign genes is done by genetic transformation (gene transfer) or also called Transfection. It is carried out to get the same purpose, as viral or chemical transformation, by which a stable or transient change is obtained in the cell. But, it is accomplished with the help of DNA which is tailored as per the needs/aims.

Transgenic plants possess a wide variety of potential uses, among which crop improvement is most significant. It includes the goals like herbicide resistance, insect resistance, changes in oil and protein contents of the crops, enhanced quantities of products, etc. The overall transformation process includes the following steps:

1. Gene transfer.
2. Selection of transgenic plants.
3. The recovery of transgenic whole plants.

Gene transfers or DNA delivery systems are of following types:

(1) Vector mediated:
- Using *Agrobacterium tumefaciens*
- Using viral vectors

(2) Vector-iree (Direct Gene Transfer)
- Electrical methods (Electroporation)
- Physical methods
- Microinjection, Silicon carbide whiskers, Micro projectile bombardmet (Biolistic gene transfer), Sonication.
- Chemical methods
- Using polyethylene glycol (PEG), Fusion of protoplasts with liposomes.

Gene transfer using *Agrobacterium tumefaciens*

This gram negative bacterium commonly occurs in soil, and causes 'crown gall disease' in higher plants. It enters the plant through the mechanically wounded tissue site. This infection causes local proliferation of undifferentiated tissue (tumorous outgrowth). Agrobacterium tumefaciens possesses a special ability to transfer some of its DNA into nuclear DNA of an infected host plant because of functions encoded on its "Ti" (tumour-inducing) plasmid. The transferred DNA, or X-DNA, of this plasmid encodes substances which act as plant hormones, causing the proliferation of tissue seen in the infected plant. Ti-plasimd of this bacterium has been modified by means of genetic engineering to create "disarmed" plasmids (also called vectors) which can carry any DNA seuence into A.tumefaciens-infected plants, without tumorous growth on the host plant. These cloning vectors derived from. Ti-Plasmid has been used for replication in both A.tumefaciens and Escherichia coil bacterial strains. This makes possible the cloning of foreign DNA sequences into the vectors using *E.coli* host, as well as the further transfer of the completed vector to an *A.tumefaciens* host.

Gene transfer by Electroporation

This technique is based on the use of short electrical pulses of high field strength to promote DNA uptake by protoplasts. The optimal electroporation conditions may vary in different plant species. Buffers greatly influence the gene transfer efficiency and also the protoplast survival rate.

Microinjection

Microcapillaries and microscopic devices are used to deliver DNA into protoplasts. It is considered as one of the most precise techniques. But it is a very skilled process and also expensive equipments are required.

Biolistic Gene Transfer

The DNA is bombarded into the intact cell using a biolistic device such as particle gun. It can only be used for intact tissues. Because pressure is to be applied, it is not suitable for protoplasts. Like microinjection, this is also a very precise technique.

Silicon Carbide Whiskers

Silicon carbide forms long, needle shaped crystals (whiskers) in solutions like ink polyethylene glycol, 1-3%. When cells are vortex mixed in the presence of whiskers and DNA, the DNA can be introduced into the cells following penetration by whiskers.

Gene Transfer using Chemical Agents

Various chemical treatments have been used to stimulated DNA uptake by protoplasts. Among them polyethylene glycol is the most common. It acts by increasing the permeability of cell membranes. The optunal concentrations of PEG are 15-20%.

Tobacco was the first plant to be genetically transformed, in 1983, with cereals beginning in 1990. Recently genetically modified Soya has reached the market.

Most cereal food crops in the Western countries have been made insect and pest resistant by incorporating suitable genes. Owing to this, percentage spoilage of crops per annum has sharply reduced. Consequently the use of these harmful chemicals has also been drastically reduced, proving to be beneficiary to the environment.

Transgenic Plants as a Source of Vaccines

It has been found that developing nations are still deprived of modern vaccines. This is mainly because of refrigeration and other equipments needed for such programmes. It has been shown that the plants can be utilized for preparing vaccines. The reason is they can be induced to synthesize appropriately folded bacterial land viral proteins that stimulate immune response.

Specific DNA sequence encoding for the expression of a surface antigen of a pathogen is isolated and ligated to a promoter (e.g. Cauliflower Mosaic virus 35 S promoters) which can regulate the production of the surface antigen in a transgenic plant. This gene is then transferred to plant cells using a

procedure that results in its integration into the plant genome, such as through the use of Agrobacterium tumefaciens plasmid vector system.

Plasmid containing Hepatitis B surface antigen gene containing a promoter, a marker gene, and flanking T-DNA sequences has been prepared and used in A.tumefaciens mediated transformation of tomato. Transgenic tomatos, producing the antigen were produced.

[B] PLANT TISSUE CULTURES AS SOURCES OF BIO-MEDICINALS

The utility of plant tissue cultures in bio-production of natural compounds under aseptic conditions by methods similar to those used to culture microorganisms has opened new approach in the field of biotechnology. The use of tissue culture technique for biosynthesis of secondary metabolites, particularly in plants of pharmaceutical significance, holds promise for controlled production of plant constituents. In spite of the recent developments on synthetic chemistry, higher plants are still an important source of medicinal compounds. In recent years, however, it has become difficult to maintain an ample supply of medicinal plants due to several factors, such as their ruthless exploitation, lack of conservation of the environment, increasing lab out costs and economical or technical problems associated with the cultivation of medicinal plants. The technique of plant tissue cultures could afford possible solution to some of these problems. The major advantages expected from plant tissue culture systems over conventional cultivation technique may be summarized as follows.

1. The process offers the prospect of absolutely uniform biomass obtainable at all times and manageable under regulated and reproducible conditions, rarely possible in working entire living potentials.
2. It is possible to use plant cell culture technique for synthesis of those medicinal compounds which are too difficult or impossible to synthesis chemically.
3. The useful natural compounds could be produced under controlled environmental conditions, independent of soil conditions and changes in climatic conditions.
4. The technique could be used to study biogenesis of secondary metabolites. It is possible to feed labeled precursors to cell cultures and deduce interpretation pertaining to metabolic pathways of desired compound.
5. It is possible to attempt biotransformation reactions in plant cell cultures. It is expected that specific modification of chemical structures

of certain compounds may be achieved more easily in cultured plant cells rather than in micro-organisms or by chemical synthesis.

6. The cells of any plants, tropical or temperate, could be multiplied to yield specific metabolites produced by them.
7. The cultured cells could be maintained free from any microbial contamination and insect attack.
8. Another important application of plant tissue culture technique is immobilization of cells which could be used for various biotransformation or biochemical reactions. A particular strain of cells obtained from suspension cultures in immobilized by suspending it in sodium alginate solution, precipitating the alginate plus entrapped cells with calcium chloride solution, pelleting and allowing the product to harden.

The biotechnological potentials of plant tissue cultures have been reviewed by Reinhard. 1967, Tecuscher 1973, Butcher, 1977, Boehm 1977, Staba 1977, Tabata 1977, zenk 1978, Kurz and Constable 1979, Kokate 1979, Barz and Ellis 1981, Deus and Zenk 1982, shargool 1982, Berlin 1984, Fowler 1984 and Misawa 1984.

Historical Development

The technique of plant tissue culture is now more than ninety yeasrs old,but is only in last two decades that implications of this technique have been realized and in particular its pharmaceutical potential appreciated. Haberblandt's hypothesis (1902) that isolated plant cells should be capable of cultivation on artificial medium was directed at the study of their capacity and characteristics as elementary organisms free from multicellular system of plant. Although, Haberblandt and coworkers were unable to demonstrate this hypothesis, other workers such as Robbins in U.S.A. (1922) and kotte in Germany (1922), successfully cultured excised plant roots, possibly inspired by the hypothesis put forward by Haberblandt. In 1934, white reported successful continued culture of excised tomato root tips. In the same year, Gautheret published the first of his many classical papers on cambial tissue cultures and later in 1939 working independently of one another, White, Nobecourt and Gautheret reported the first unlimited culture of a similar undifferentiated callus of callus tissue. White (1939) reported continuous cultivation of a similar undifferentiated callus derived from procambial tissue of young stems of a hybrid Nicotiana (N.glauca * N.langsdorffii) cultured in the medium he had developed for excised tomato roots, but containing 0 – 5% agar. Gautheret (1939) examined behaviour of carrot explants on a medium compounded of inorganic salt mixture and dextrose containing aneurine, cystein hydrochloride

and a low concentration of indole acetic acid. In 1954, Muir, Hildebrandt and Ricker reported growth of liquid cultures containing single cells and small clumps of cells of Tagetes erects and Nicotiana tabaccum. In 1956, Reinert obtained evidence for occurrence of cell divisions in a similar suspension of single cells and cell groups from Picea glauca. Jones, Hildebrandt, Ricker and Wu in 1960 examined growth in hanging drop culture of separated cells from a callus of hybrid tobaccos (N.tabaccum*N.glutinosa).

Types of Cultures

Three main lines of technical development constituting methodology of plant tissue culture are concerned, respectively with the culture of isolated plant organs (Particularly of isolated roots but, to a lesser extent, of stem tips, leaf primordial, immature embryos and flower structures), the growth of callus masses on solidified media and the growth in liquid media of mixed suspensions of separated cells and small cell groups.

Plant tissue culture consists of a number of techniques for growing plant organ and cells. The organ cultures have been successfully obtained from roots, stem tips, leaves, flowers and fruits. Methods used to initiate such cultures are varied and depend upon nature of the organ acquired. Excised root cultures, for example, are initiated by placing sectioned ok lengths of surface sterilized root tip in liquid medium containing essential macro and micro-nutrients and periodically subculturing or transferring to fresh medium. They demonstrate high growth rate and metabolic activity and a low level of variability and are, therefore, important tools in determining responses to varying conditions.

The tissue may be cultured on solid agar or in liquid nutrient medium. When grown on agar medium, the tissue forms a callus or a mass of unorganized cells. The technique of callus culture is convenient for starting and maintaining cell lines, as well as, for studies pertaining to organogenesis and meristem culture. The liquid suspension cultures consist of mixture of cell aggregates, cell clusters and single cells. The growth rates of such cultures are generally much higher than on solidified medium and the technique provides for better control of the growth of biomass, because the cells are surrounded by the nutrient medium. For the same reason, the cell material should also be probably more uniform physiologically. Both callus and suspension cultures can be derived from tissues of most of the species, but the ease of starting the cultures various with the type of plant and the tissue origin. Almost any part of any plant can be induced to produce a callus and a suspension culture. The necessary tissue can be obtained from roots, seedlings, pollen, stem and leaf

portions and it usually grows as a mass of undifferentiated cells on enriched solidified medium.

CULTURE MEDIUM

Defined medium for the growth of cell cultures consists of inorganic salts, a carbon source, Vitamins, growth regulators and some organic supplements. Since the pioneer studies of Gautheret (1939) and White (1939), it has been one of the main subjects of the researchers of plant tissue culture to devise a proper medium which supports sufficient growth of cell cultures. In consequence of these studies, we now have several well defined standard nutrient media which have been used most widely in basic or modified forms such as of Gautheret (1942), White (1943), hilderbrandt et al (1946), Heller (1953), Nitsch and Nitsch (1956), Murashige and Skoog (1962), Eriksson (1965) and B_5 (1968).

An ideal nutrient medium for plant tissue cultures contains five classes of ingredients.

1.**Inorganic salts**

The concentration of potassium and of nitrate should be at least 20 – 25 mM for each, whereas concentration of 1 – 3mM of phosphate, sulfate and magnesium appear to be adequate. Ammonium is essential although amounts in excess of 8 mM could be deleterious. The recommended micronutrients are iodide, boric acid and salts of Zink, manganese, molybdenum, copper, cobalt and iron. The later is usually incorporated in the chelated form.

2. Vitamins

Thiamine is the only vitamin which appears to be essential. Pyridoxine, myo-inositol and nicotinic acid are frequently added to improve the cell growth.

3.Carbon source

Sucrose of glucose at a concentration of 2 – 4% is the most suitable carbon source.

4. Growth regulators

These substances are needed to induce cell division. The compounds most frequently used are naphthalene acetic acid (NAA) and 2,4-dichlorophenoxy acetic acid (2,4-D) in the molar concentrations of 10^{-4} to $5*10^{-5}$. Both 2,4-D and NAA are degraded very slowly by plant cells and are stable to autoclaving Cytokines such as Kinetin or benzyladenine (10^{-7} to10^{-5} M) are sometimes required in conjunction with 2,4-D or NAA to obtain good callus formation.

4. Organic supplements

Protein hydrolyzates, yeast extract, malt extract and coconut and coconut milk (liquid endosperm) are used for enhancement in the growth rate of the cells in bio-mass.

The chemicals are dissolved in glass distilled water, the stock solutions of vitamins, micro-nutrients and growth hormones are added and the pH of the medium is adjusted to 5.5 to 5.7. The solution is made to volume and then 50 and 100 ml quantities are distributed into 250 ml Erlenmeyer flasks. The flasks are stoppered with cotton wool plugs, and autoclaved at 120^{o}c for 15 minutes. The flasks are removed for cooling, as early as possible. The agar medium is autoclaved in lots of 500 ml and subsequently poured into sterile containers. All media are stored at 10^{o}c prior to use.

SURFACE STERILIZATION OF EXPLANTS

It is necessary to effect surface sterilization of the organ from which the tissue is to be aseptically excised or of the spore or seed whose germination shall yield the tissue explant. The commonly used surface sterilizing agents are sodium hypochlorite (1 – 2%), bromine water (1 – 2%), hydrogen peroxide (10 – 12%) mercuric chloride (0.1 – 1%) and silver nitrate (1%).

The seeds are treated with 70% ethanol for about 2 minutes, washed with sterile distilled water, treated with surface sterilizing agent for a specific period, once again rinsed with sterile distilled water and kept for germination under aseptic conditions. The seeds may be germinated aseptically by placing them on double layers of pre-sterilized filter paper in Petri dishes moistened sufficiently with sterile distilled water or on moist cotton plugs in Petri dishes or culture tubes. The seeds are germinated in dark at 26 – 28^{o}c and small part of the seeding is utilized for the initiation of callus culture.

The aerial portion of plants such as bud, leaf and stem sections are sterilized by submerging for 2 – 3 minutes in 70% ethanol followed by 2 – 3 rinses in sterile distilled water.

ESTABLISHMENT OF CULTURES

The surface sterilized plant material is aseptically transferred on solidified nutrient medium in flasks, glass jars or culture tubes and allowed to incubate at 26-28oc in dark. After 3-4 weeks, the callus should be about 5 times the size of the explant. Many tissue explants possess some degree of polarity with the result that callus is formed most easily at one surface. In stem segments, callus is formed particularly from the surface which in-vivo is directed towards the root. The callus often develops more readily from the tissue not in contact with and particularly not immersed in the solidified culture

medium. The maintenance of growth in callus tissue by subculturing requires the transfer on each occasion of a piece of healthy tissue every 4 weeks into the flask containing fresh solidified nutrient medium. Many cultures shall, however, remain healthy and continue a slow rate of growth for much longer periods without subculturing, if the standard incubation temperature of 26oc is lowered to 5-10oc. It has been observed that the growth of many cultures and particularly of those which form chlorophyll is stimulated by low-intensity illumination. Light either on a 12 h cycle or continuously is therefore usually provided in the incubation chambers by fluorescent tubes.

The suspension cultures are generally initiated by transferring an established callus tissue to an agitated liquid nutrient medium in Erlenmeyer culture vessels (30-60 ml medium per250 ml flask). The composition of the medium for establishment of suspension cultures should be same as defined for callus cultures except for addition of agar. The soft callus generally forms a suspension culture without much difficulty. The release of cells and tissue fragments from less friable callus masses and the maintenance of a good degree of cell separation may often be promoted by the presence in the liquid medium of a high auxin concentration, an appropriate balance between yeast extract and auxin or between auxin and kinetin. The suspension cultures are usually incubated at 25oc in darkness or low intensity fluorescent light. Continuous agitation of flask cultures is most commonly achieved by using a horizontal shaker which rotates at between 100 and 200 revolutions per minute. The culture flasks are sealed with double aluminium foils or parafilms to reduce evapo4ration during the process of culture growth. A cell suspension should be formed within 4 to 6 weeks. The cells grown in cultures are meristematic and generally undifferentiated and there is no significant evidence that cells of shoot or root origins are metabolically different. The suspension cultures are subcultured by the transfer at regular intervals of intervals of untreated or fractionated aliquots of the suspension to fresh medium.

There are several parameters for measuring growth of cultured cells such as measurements of cell number, packed cell volume, fresh and dry weight, total nitrogen, etc. None of these methods reflects growth in all its facets which include cell division, elongation and differentiation. The method of measuring growth of cultured cells by dry weight determination has the advantage of being a method which is simple, used quite commonly and gives an acceptable assessment of overall synthetic activity of cells.

Presently plant tissue culture is practiced for two main purposes viz. regeneration of plants and formation or production of useful secondary metabolites. Regeneration of whole, fertile plants from selected or

biotechnologically engineered cells has been achieved in many cases. It is done mainly with the technique of organogenesis and in few cases with embryogenesis. Plant regeneration technology is applied for various purposes like production of virus-free plant, germplasm storage and studies on plant biology.

Organogenesis, mainly includes root or shoot formation. The technique requires either the preexisting meristematic primordial which is available through the medium of explant or induced meristematic primordial. The induction of plant hormones like auxins, cytokinins and also their relative proportion with each other. Certain observation and consequently guidelines in case of role of plant hormones are summarized here.

1. The balance between formation of root or shoot is governed by ratio of auxin to cytokinin (auxin to cytokinin in 4:1 proportion causes shoot formation and auxin to cytokinin in 100:1 proportion causes root formation). IAA favour shoot formation and NAA favours root formation.
2. High auxin concentraion cause the formation of meristem like cells.

By means of clonal propagation, technique of regeneration of plants has been commercially exploited for routine multiplication of agricultural and ornamental plant species

For the development of virus-free plants, meristem tip culture technique is used. Plant meristems are found to be virus-free as many of plant viruses cannot enter or survive in meristematic tissue. The meristem tip culture is propagated from apical shoot tips and used as a source of sterile shoot cultures, which are further regenerated into virus-free plants.

Followed by the success in developing the technique of isolating the protoplasts from cell walls, protoplast fusions have achieved through the medium of protoplast culture. It is used for the purpose of somatic hybridization of plant cells. Cell wall can be efficiently hydrolysed by using cell-wall degrading enzymes like cellulase, hemicsellulase and pectinase. Isolated protoplasts are mounted in proper medium containing mannitol/sorbitol for maintaining osmolarity. The protoplast fusion is done by chemicalfusion or electrofusion. It may be a self-self fusion or binary fusion. The later is of only use for regeneration. Through protoplast fusion technique, it is possible to get desired plant characters like higher yields, diseases resistance etc.

Besides regeneration of plants, plant tissue culture techniques have been much applied for development of secondary metabolites. The technique has been extended to large number of plants and a variety of secondary products have been reported to accumulate in cultures.

Along with cell suspension culture, other cultures have also been employed. Still cell suspension culture systems have been most widely used mainly due to potential for scale-up to biorector levels. Through cell suspension culture, higher levels of secondary products yields have been reported for ginsenosides from panax ginseng, shikonin from Lithospermum erythrorhizon serpentine from Catharanthusroseus etc.

The factors conventionally used for manipulation of yield of secondary metabolite in cell suspension cultures are light, temperature, osmotic stress, concentrations of nitrogen, carbohydrate and phosphate source, plant hormones, precursors and elicitors like fungal extracts.

For the accumulation of secondary metabolites in cultures, now-a-days hairy root cultures have been much used. Such cultures are developed by way of incorporating a segment of "Ri-DNA" from Agrobacterium rhizogens into the plant genome which brings out phenotypic characters called 'hairy roots'. These are able to grow rapidly and indefinitely with profuse lateral roots. They grow on a medium without plant hormones and can accumulate levels of secondary metabolites similar to those occurring in natural roots. Many plants have been subjected for this purpose. However, this technique has shown success only in non-woody dicotyledonous plants.

ANALYTICAL PHARMACOGNOSY

The chemistry of plants is as divergent as the great variety of form in which plants occur. The therapeutically important constituents are usually found to be associated with many inert substances such as colouring matters, cellulose, lignin, cutin suberin, etc. The active principle are extracted from plants drugs and purified for therapeutic utility for their selective and regulated activity. The quality control of herbal crude drugs and their bio-constituents is of paramount importance in justifying their acceptability in modern system of medicine. One of the major problems faced by user industry is non-availability of rigid quality control profiles for herbal raw material and their formulations. With the advent of new analytical tools and sophisticated instrumental technology, it is possible to suggest a practicable quality assurance profile for a crude drug or its bioactive constituent.

Owings to the medicinal properties attributed to crude drugs, it is necessary to maintain its quality and purity in commercial market. It is,

however, observed that the drugs in commerce are frequently adulterated and do not comply with standards prescribed for authentic drug.

[A] DRUG ADULTERATION

Adulteration is a practice of substituting original crude drug partially or wholly with other similar looking substances but the later is either free or inferior in chemical and therapeutic properties. Adulteration in simple terms is debasement of an article. The motives for intentional adulteration are normally commercial one and are originated mainly with the intention of enhancement of profits. Some of the reason that can be cited here are scarcity of drug and its high price prevailing in market. The adulteration is done deliberately, but it may occur accidentally in some cases. It is also very common with the contraband drugs. Adulteration involves different condition such as deterioration, admixture, sophistication, substitution, inferiority and spoilage. Deterioration is impairment in the quality of drug, while admixture is addition of one article to another due to ignorance or carelessness or by accident. Sophistication is the intentional or deliberate type of adulteration. Substitution occurs when some totally different substance is added in place of original drug. Inferiority refers to any substandard drug, and spoilage is due to the attack of microorganisms.

A variety of adulterants are found in naturals drugs by which the methods employed for practices can be enumerated. During the routine quality controls, various tests are applied for their detection. The present chapter deals with different techniques used in adulterating crude drugs and laboratory methods for their detection.

TYPES OF ADULTERANTS

Generally, the drugs are adulterated by substitution with substandard commercials varieties, inferiors drug or artificially manufactured commodities. The different types of adulterants founds in markets are given here.

i. Substitution with substandard commercial Varieties: The adulterants used here may resemble original crude drug by morphological, chemical or therapeutic characters, but are substandard in nature and hence cheaper in cost. This is rather a most common practice of adulteration. The examples are presence of Strychnous nux-blanda or S. potatorum in place of S. Nuxvomica; Capsicum minimum replaced by C. Annuum; Indian senna substituted with Arabian senna and dog senna; gentian substituted by kutki; medicinal ginger replaced by its inferior varieties, viz. African, Japanese and Cochin ginger.

ii. Substitution with superficially similar inferior drugs: These inferior drugs used may or may not be having any chemical or therapeutic value as that of original natural drug. Due to their morphological resemblance to authentic drug, they are marketed as adulterants. Belladonna leaves are substituted with Ailanthus leaves; saffron is admixed with dried flowers of Carthamus tinctorius; scented bdellium is used for myrrh; mother cloves and clove stalks are missed with clove; and beeswax is substituted by japan wax.

iii. Substitution with artificially manufactured substances: It has been also observed that substances artificially prepared to resemble original drug are used as substitutes. Generally, this practice is followed for much costlier drugs. Compressed chicory in place of coffee; paraffin wax made yellow coloured and substituted for beeswax properly cut and shaped basswood for nutmeg are some of the examples representing this type of adulteration.

iv. Substitution with exhausted drugs: In this type, the same drug is admixed but is devoid of any medicinally active constituents as they are already extracted out. This practice is more common in case of volatile oil containing drugs like fennel, clove, coriander, caraway etc. Sometimes, natural characters of exhausted drugs like colour and taste are manipulated by adding other additives and then it is substituted, e.g. exhausted gentian made bitter with aloes, artificial colouring of exhausted saffron, etc.

v. Besides these common practices, sometimes other methods are employed like use of synthetic chemicals to enhance the natural character as in case of addition of benzyl benzoate to balsam of Peru, citral to citrus oils like oil of lemon and orange oil, etc.

vi. Presence of vegetative matter from the same plant: Sometimes, the other miniature plants growing along with medicinal plant are mixed with drug due to their resembling colour, odour and in some cases constituents. The lower plants like moss, liver worts and epiphytes growing on bark portion are mixed with cascara or cinchona. The stem portions are mixed along with leaf drugs like stramonium, lobelia and senna.

vii. Harmful adulterants: Several times, the wastes from market are collected and admixed with authentic drugs. This is particularly

noticed for liquids or unorganized drugs. The examples like pieces of amber coloured glass in colophony, limestones in asafetida, lead shot in opium, white oil in coconut oils, cocoa butter mixed with stearin or paraffin indicate this type of adulteration practice. The addition or rodent faecal matter to cardamom seed is a very harmful adulterant.

Viii. Adulteration of powders: Besides the entire drugs, the powdered forms are frequently found to be adulterated. Some examples which can be cited here are dextrin in ipecacuanha, powdered liquorice or gentian admixed with powdered olive stones, exhausted ginger powder in powdered colocynth or ginger, red sanders wood in capsicum, etc. The powdered bark is frequently found to the adulterated with brick powder.

(B) DRUG EVALUATION

Evaluation of a drug means confirmation of its identity and determination of its quality and purity and detection of nature of adulteration. The evaluation of a crude drug is necessary because of three main reasons (1) biochemical variation in the drug, (2) deterioration due to treatment and storage, and (3) substitution and adulteration, as a result of carelessness, ignorance or fraud.

Over the years the nature and degree of evaluation of crude drugs has undergone a systematic change, initially, the crude drugs were identified by comparison only with the standard description available. Due to advancement in the chemical knowledge of crude drugs, at present, evaluation also includes method of estimating active constituent present in the crude drug, in addition to its morphological and microscopic analysis. With the advent of separation techniques and instrumentation analysis, it is possible to perform physical evaluation of a crude drug, which could be both of qualitative land quantitative nature. The biological behaviour of crude drug extracts constitutes pharmacological evaluation.

The crude drugs can be identified on the basis of their morphological, histological, chemical, physical and biological studies. The different techniques involved in standardization of crude drugs are as follows.

1. MORPHOLOGICAL OR ORGANOLEPTIC EVALUATION.

It refers to evaluation of drugs by colour, odour, taste, size, shape and special features, like touch, texture, etc. It is a technique of qualitative evaluation based on the study of morphological and sensory profiles of whole drugs. Organoleptic evaluation means conclusions drawn from studies resulted due to impressions on organs of senses. The study of form of a crude drug is

Morphology while description of the form is Morphography. The fractured surfaces in cinchona, quillaia and cascara barks and quassia wood are important characteristics. Aromatic odour of umbelliferous fruits and sweet taste of liquorice are the examples of this type of evaluation. The ovoid tears of gum acacia, ribbon shaped characteristic of tragacanth, disc-shaped structure of nux-vomica, conical shape of aconite, quills of cinnamon etc. are important diagnostic characters. The general appearance of the lot of a crude drug often indicates whether it is likely to comply with prescribed standards, such as percentage of seed in colocynth, stalk in clove, etc. Over drying, makes leaf drugs and flowers brittle and cause them to break in transit making the task of morphological evaluation difficult.

The wavy shape of rauwolfia, pungent taste of capsicum and ginger, brown colour of cinnamon, odour and taste of spice-drugs like, asafetida, black pepper, nutmeg, caraway, cumin, etc. are important diagnostic organoleptic characteristics.

2. MICROSCOPIC EVALUATION

This method allows more detailed examination of a drug and it can be used to identify the organised drugs by their known histological characters. It is mostly used for qualitative evaluation of organised crude drugs in entire and powdered forms.

Microscope, by virtue of its property to magnify, permits the minute structure under study to be enlarged and can be used to confirm the structural details of the drugs from plant origin. For the effective results, various reagents or stains can be used to distinguish cellular structure. Microscopic evaluation also covers study of the constituents by application of chemical methods to small quantities of drugs in powdered form or to histological sections of the drug (Microchemistry or lchemomicroscopy). A drop of phoroglucinol and concentrated hydrochloric acid give red stain with lignin. Mucilage is stained pink with rhuthenium red and also, when treated with corallin soda and few drops of sodium carbonate solution, cellulose swells and dissolves in cuoxam, while N/50 iodine solution stains starch and hemicellulose blue.

Histological studies are made from very thin sections of drugs. The characteristics of cell walls, cell contents, starch grains, calcium oxalate crystals, trichomes, fibres, vessels, etc. can be studied in details, e.g. lignifired trichomes in nux-vomica, warty trichomes of senna, wavy medullary rays of cascara bark, glandular trichomes of mint etc. Few important types of trichomes are shown below. Microscopic linear measurements and quantitative microscopy are also covered under this technique of evaluation. The powdered

clove stalks. Powdered cloves do not contain sclereids or calcium oxalate crystals, but both of them are present in powdered clove stalks. Powdered clove fruits show presence of starch, while it is absent in cloves. Presence of non-lignified vessels in powders of rhubarb and ginger indicate adulteration. The presence or absence of crystals of aloin indicates different varieties of aloes.

Other important histological aspect is the quantitative microscopy and linear measurements. The various parameters studied here are stomatal lnumber and index, palisade ratio, vein-islet number, size of starch grains, length of fibres, etc. Senna varieties are distinguished by differing stomatal number and palisade ratio. The diameter of starch grains of Cinnamomum cassia is 10 microns and hence, useful for detecting adulterants. The number of sclerenchymatous cells per square mm of cardamom is useful for detecting different varieties of cardamom seed.

5. BIOLOGICAL EVALUATION

When the estimation of potency of crude drug or its preparation is done by means of its effect on having organisms like bacteria, fungal growth or animal tissue or entire animal, it is known as bioassay. This method is generallyl called for, when standardization is not adequately done by chemical of physical means and also for conformity of therapeutic activity of raw material and finished product. In other words, bioassay is the measure of sample being tested capable of producing biological effect as that of the standard preparation. Such activity is represented in units known as International Unit (U). The specific biological activity contained in each I.U. of the few drugs is mentioned as under.

Digitalis - 1 IU is contained in 76 mg of standard preparation.

Vit.A - 1 IU is present in 0.344 micrograms of standard preparation.

Vit.D - 1 IU is contained in 0.025 micrograms of standard preparation.

Heparin - 1 IU is present in 7.7 micrograms of standard preparation.

Biological assay methods are mainly of 3 types, (i) toxic, (ii) symptomatic, and (iii) tissue methods. In toxic and symptomatic techniques, the animals are used, whereas in tissue method, the effect of a drug is observed on isolated organ or tissue. Among the drugs that are subjected to bioassay are cardiac glycosides, natural pesticides and antibiotics.

BIOLOGICAL TESTING OF HERBAL DRUGS.

In standardization/evaluation of herbal drugs, assessment of biological efficacy is found to be most assuming method. Hence, protocols followed for assessment of some types of biological activities have been given here.

In all these methods, requirements are a suitable animal model for testing and control, methodology for experiment and assessment of results.

(a). Hepatoprotective Activity.

For this purpose, male/female albino rats are used. A number of chemicals, drugs, industrial pollutants or hepatitis virus, ethyl alcohol and immunogenic reactions are known to cause hepatitis.

Most commonly used liver damaging agents are either carbon tetrachloride which causes acute toxicity or alcohol, paracetamol, rifampicin may be used which cause sub-acute or chronic toxicity. The parameters used to assess liver toxicity are

(a). Physiological (hexobarbital hyposis).

(b). Biochemical serum estimation of enzymes like SGPT, SGOT, super oxide dismutase and other factors like blood proteins, cholesterol, triglyceride levels etc.

(C) Histopathological-(liver tissue necrosis and fatty degeneration).

After ensuring the induction of toxicity, drug treatment is given for 10-15 days and recovery from damage/toxicity is verified by testing the same parameters.

For testing hepatoprotective activity, cultured hepatocytes are used in in-vitro method. For this purpose, hepatic cells are isolated using collagenase and their viability is determined. Their cultures are prepared and then a liver damaging agent and herbal drugs are added. The hepatrocytes culture with later additions is maintained for a suitable period after which enzyme activity e.g. transaminase levels are found out to assess liver functions.

(b) Hypoglycaemic Activity

In traditional systems, a number of plant extracts have been used for their hypoglycaemic activity like Kerela (Momordica charantia), Jambul (Syzigium cumini), fenugreek (Trigonella foenum-gracecum) Gudmar (Gymnema sylvestre). They are used in treatment of diabetes mellitus. For the testing purpose, experimental diabetes is induced in animals generally by alloxan or streptozocin. Due to alloxan, a urea derivative, selective necrosis necrosis of pancreatic islet- β cells occurs. By using a suitable dose of alloxan, moderate diabetes (Fasting Blood sugar levels 180-250 mg/ml) is induced and in such cases herbal drug extracts are tested.

Fermentation of streptomyces achromogenes produces a cytotoxic nitrourcido glucopyranose derivative called streptozocin, which induces diabetes. Many – a – time, normal animals are also used to test hypoglycaemic activity of plant extracts. This is a non-diabetic animal model. Before treatment with plan extract, glucose loading is given or animals are fasted and then glucose tolerance test is carried out.

Animals used for these tests are rabbits, rats or mice. Streptozocin in a single oral does (rates-80 mg/kg and mice -150 mg/kg) develops diabetes in 4-7 days. For alloxan, a single injectable dose for all types of animals (140 -180 mg/kg) is given in marginal ear vein of rabbit or intraperitoneally in rats or mice. Alloxan causes diabetes in 2 days in rats/mice and in 7 days in rabbits.

In all the cases, blood glucose levels are measured by two classical methods using glucose oxidase or ortho-toluidine. Glucose autoanalysers are also used. In glucose tolerance tests, sometime, insulin levels are measured to find out whether glucose itself or plant extracts are stimulating insulin secretion, to cause hypoglycaemic effect. Radio –immunoassay (RIA) or enzyme linked immunosorbate –assay (ELISA) are done for measurement of insulin levels.

(c) Anti-fertility Testing

Although a number of herbal drugs have been used for abortificient, antifertility activity, few of them show scientific evidence like embelin from Embelia ribes as abortificient or gossypol from Gossypum species as male anti-fertility agent. Due to overgrowing population in developing countries, and severe side efforts of synthetic anti-fertility drugs, plant drugs are gaining increasing significance in this context. Such activities of these drugs are known to occur in following ways.

(a) in females

(i) Destruction of zygotes (early abortion)

(ii) Prevention of ovulation, fertilization or implantation.

(b) In males

(i) Spermicidal (ii) anti-androgenic

Anti-fertility drugs include contraceptives and abortificients. Contraceptive drugs are used to prevent pregnancy and abortificients are used to terminate pregnancy. In females, the estimation of antifertility activity measures the pregnancy rate and hance, includes anti-ovulation and anti-implantation drugs. Inhibition of spermatogenesis or sperm motility is considered in males.

(1) Protocols for Anti-fertility activity in Female Rats : Female rats are placed singly and eventually acclaimatised for about 8 – 10 days. Normal oestrus cycle is assured by taking vaginal smears after 10-14 days. The animals are then given daily doses of herbal extracts to see the changes like oestrogenicity (e.g. increase in weight of uterus, cornification of vagina). Further the animals are paired with male rats which are proven breeders. Mean while, daily dose of herbal extract is continued. Mating is detected with the help of vaginal smeats. Absence of mating may indicate possibly the lack of oestrogen and / or progesterone. The reason may be antigonadotrophic activity or peripheral antagonism. In the case of mating, one group of rats is continued with daily dose of drug for next 7 days. After this their uteri, ovaries and viducts are examined. The absence of ovulation is possibly due to contraceptivce activity. In the second group of animals, dose is continued upto day 19. If there is no weight gain, it may be contraception or anti-implantation. Bleeding or the loss of gained weight may be due to abortificient effect.

(II) Antispermatogenic activity in male rats: After acclaimastisation, adult male rats are given a daily dose of herbal drug extract for 60 days. Between days 12 – days 15, each male rat is mated with a female rat (undergoing proestrus or estrus cycle). Subsequent mating is arranged between days 56 to 60. After this, testes of each male rat are morphologically studied and weight is noted. Sperms are examined under microscope. Beside, histopathological studies of testes are also carried out. If there is no fertilization due to mating between days 12 – day 15, it is considered as functional sterility; while that between days 56 – day 60 will be due to antispermatogenic activity of herbal drug extract.

(III) Spermicidal activity: It is a simple method and can be carried out in vitro directly on human semen. The fresh sample of human semen taken on slide is added with two drops of herbal drug extract in Sorensen's phosphate buffer, mixed well and observed under microscope for motility of sperms. Immobility of sperms occurs, in case of spermicidal herbal drug extract.

An occlusion in vas deferens in male rat can occur due to granuloma type tissue formation there, leading to male sterility. It can be assessed by carrying in vitro testing in male rats.

(d) Anti-inflammatory Activity

A number of drugs from plant sources are known to cause anti-inflammatory effects and used in conditions like rheumatoid arthritis, gout, dysmenorrhoea etc. There are many sites in body where these types of drugs can act. Inflammation may occur due to mechanical causes, infections or autoimmune diseases. In the damaged tissues in such cases, lysosomal

enzymes and other products are released by polymorphonuclear leukocytes. This leads to number of complex inter-related pathways, finally release of kinins, prostaglandins and histamine causing inflammation as vascular effects.

The principle underlying the testing of anti-inflammatory activity is the reduction of local oedema induced in rat paw by injecting irritant, inflammatory substances. Most common inducer is carrageenam which is a mucopolysaccharide isolated from Irish Sea moss Chondrus cripus, given in the dose of 0.1 ml, 1 % w/v in saline. Before the test, the antagonist (herbal drug extract) is given orally 1 hr. or 30 minutes intraperitoneally before the test. Agonist (carrangeenan) is injected into planter surface of the right hind-paw and volume of paw is measured just after injection, and they every after an hour subsequently for 5 times. Volume of paw is measured by volume displacement method e.g. using plethysmometer.

Another method employs albino adult mice, in which erythema and odema is produced in pinna of ear using agonist as croton oil (1 mg/ear). Test plant extracts are applied to pinna of ear, and 15 minutes after croton oil is kapplied over the same area. Measurement of anti-inflammatory effects is done by simple method like expressing as O-no activity, + slight and ++ pronounced. Odema is measured by vernier callipers.

(e) Neuropharmacological Activity

Plant Kingdom is rich of various medicinal species having their effects on nervous system. They are used or abused for medicinal or narcotic purposes. Some of them like Opium, Pilocarpus, and Brahmi have potential therapeutic uses also. Now-a-days the pharmacological spectrum and biological efficiency of such herbal drugs can be suitably established due to development of various neuropharmacological testing protocols. They have been outlined here as:

(i) testing of herbal drugs with effects on central nervous system;

(ii) Testing of herbal drugs with effects on autonomic nervous system.

CNS-acting drugs are classified as stimulants – cocaine (Erythroxylon coca), and tetrahydrocannabinol (Cannabis Sativa), depressants – morphine (Papaver somniferum), tranquilisers (Rauwolfia spp.), hallucinogens – psilocin (Psilocybe mexicana), and antidepressants. CNS acting drugs are tested by following methods in rodents.

(i) Locomotor activity in mice.

(ii) Locomotor co-ordination.

(iii) Penetrazole convulsions in mice.

(iv) Barbiturate sleeping time.

Locomoto activity is measured on mice by using an instrument called activity cage in which the movement of animals across a light beam is measured and taken as locomotion count. The test represents the CNS – stimulant or depressant profile. Locomotion co-ordination is assessed by means of rotating bar on which mice are placed.

Activity of anti-convulsant herbal is assessed in mice, where the convulsions are induced by penetrozole (80-120 mg/kg) intraperitoneally). The factors measured are time to onset of convulsion after drug treatment, number of convulsive periods during observation period, number of convulsing animals and mortality rate.

Barbiturate sleeping time is used to assess stimulant or depressant effects on CNs. Sleeping time is measued in terms of righting reflex. To induce sleep, barbiturates like pentobarbitone (55 mg/kg) or hexobarbitone (35 mg/kg) are used. kProlongation or reduction of sleeping time may inducate depressant or stimulant activity of herbal drug.

For testing the effects of herbal drug extracts on autonomic nervous system, following types of invitro preparations are used with their possible purposes as mentioned alongwith:

1. Guniea – pig ileum (for non-specific anti-spasmodic activity).
2. Isolated Rabbit Jejunum (Adrenergic activity and mechanism).
3. Rat Phrenic – Nerve –Diaphragm (Muscle relaxant activity).
4. Frog Rectus – Abdominals Muscle. (Activity on skeletal muscles).

1. Guinea – Pig Ileum preparation

It has a number of uses in testing of ANS drugs because of its specific characters. Guinea – pig ileum contains a network of intrinsic parasympathetic nerves (Auerbach and Meissuer's plexuses) present between circular and longitudinal muscle layers. It also contains non-adrenergic non-cholinergic nerves. Hence, guinea – pig ileum is useful for drugs causing nerve mediated and directly stimulated contractions. Guinea – pig ileum does not give large spontaneous contractions. Ganglion blocking or stimulating activity of drugs can be studied because Auerback plexus in guinea – pig ileum has parasympathetic ganglion bodies and they can be stimulated by nicotinic receptor agonists.

For the purpose of setting up the guinea-pig ileum preparation, food is withdrawn for overnight, and then the animal is killed. Suitable length of ileum (except first 5 cm. next to catecum) is separated from mesenteric attachment and put in physiological salt solution. Ileum is emptied off its contents. A piece measuring about 1.5 – 2 cum length is mounted in physiological salt solution in jacketed organ parasympathomimetics (acting either as anticholinesterases or ACH receptor agonist) and parasympatholytic drugs (acting either to prevent action of ACH or its release). During these experiments, graded doses of ACH are given for ileum stimulation, after which herbal drug is given.

Due to drug treatment, if ACH type contractions are produced, and persist even after giving a dose of histamine H1-receptor antagonist, then it may be indicated that it is a cholinergic drug. This can be verified by blocking effect with atropine. This does not distinguish between muscarinic and nicotinic receptor activity. If the contractions caused by herbal drug are blocked by a ganglion – blocking agent (e.g.hexamethonium or coniine) then it may be indicated that herbal drug has a nicotinic receptor mechanism. Besides, cholinergic activity, the contractions occurred due to drug may be because of its activity, the contractions occurred due to drug may be because of its activity at other receptors like histamine.

If the herbal drug shows inhibition of contractions due to ACH (but not histamine), it may have anticholinergic (parasympatholytic) activity. For verification of muscarinic receptor blockade, dose-response curves are found out which may show competitive or non-competitive antagonism. Nicotinic receptor type blockade may be indicated using hexamethonium.

Besides muscarinic and nicotinic receptor blockade, parasympatholytic activity is observed due to morphine also which prevents release of ACH from cholinergic nerve endings. Such type of activity in drugs can be found by mounting longitudinal muscle strip of guinea – pig ileum in between two platinum electrodes.

2. Isolated Rabbit Jejunum Preparation

This type of preparation is used to find out nerve – mediated and direct muscle – stimulated adrenergic effects. For mounting purpose, rabbit jejunum is isolated along with mesenteric vessels as the vessels are associated with sympathetic nerves. The mesentery vessels are carefully cut off and then isolated rabbit jejunum with periarterial nerves is mounted in physiological salt solution in jacketed organ bath at a constant temperature (32 -37^{o}C). The nerves are connected through an electrode and stimulated. If these are relaxed by plant drug, it may have either noradrenaline like effect or through other

mechanism like calcium channel blockade or opening potassium channels. If the action of drug is blocked by adrenergic receptor antagonists, it may be indicated that drug has an effect on adrenoreceptors.

A drug may show blocking effect on periarterial nerve stimulation (adrenergic neurone blocking property) and hence, indirectly cause relaxation of jejunum.

3. Rat Phrenic Nerve – Diaphragm Preparation

Phrenic nerve – diaphragm is isolated from frontal part of right thoracic wall. It is mounted on a special phrenic nerve electrode. Here the broad end of diaphragm (cu into triangular form) is tied at two points while muscle of diaphragm is allowed to remain across the length of platinum electrode (at one end). The preparation is joined to recording device by tendinous end of triangle.

Inhibiting indirectly, the stimulation of diaphragm muscle by the drugs is considered important because this effect is mediated through neuro-muscular junction.

(f) Testing for Anti-Ulcer Activity:

Various factors are responsible for increase in acidity, and they include diet, alcohol, stress (mental and physical), and certain drugs especially non steroidal anti-inflammatory molecules. Gastric and duodenal ulcers range from simple gastritis to ulcers observable by X-rays, Plant drugs mainly used as anti-ulcerogenic, include liquorice, atropine, hyoscine and to a less extent gefarnate from white cabbage juice.

For testing of anti-ulcer activity of a herbal drug, the ulcer is induced by either of the following agents.

(1) Chemicals: Alcohol (1 ml/kg body weight, orally) aspirin (200 mg/kg body weight orally) endomethacin, serotonin (5-HT), prednisolone.

(2) Stress: The stimuli like imobilisation and cold. (Animal is immobilized in a cylindrical cage and maintained at 3-5^{o}C). Animal model used is rat (male, wistar); sometimes guinea – pigs are also used. The animals are grouped as (i) Those treated with normal saline only (ii) Those treated with ulcerogen in saline or ulcerogenic stress procedure (iii) Test groups : Along with ulcerogen (chemical/stress), a known anti-ulcer drug like liquorice or ranitidine.

During the procedure, the ulcers are induced by administering ulcerogen (chemical/stress); after one hour, the animals are sacrificed, and the stomach or duodenums (for histamine-induced ulcers) are given a slit along the curvature. These organs are opened for assessment of damage due to ulcer. In

some experiments, the gastric acid is measured. For this purpose, before slitting along curvature, the stomach is ligated and the contents are drained and collected.

The severity of ulcer damage, due to ulcerogen and also the protection offered by herbal anti-ulcer agents, is assessed by 'Ulcer Indix'. For assessing ulcer index, the number and size of ulcerative lesions is considered. Ulcer index is expressed on simpler scale as

0	=	No damage
1	=	Redness of mucosa
2	=	Erosion of mucosa
3	=	Ulceration

in elaborate way, it is expressed in following way.

0	=	Absence of ulcer
1	=	Slightly dispersed and haemorrhagic ulcers (less than 2 mm length)
2	=	One ulcer upto 5 mm in length
3	=	More than one ulcer
4	=	One ulcer above 5 mm in length
10	=	Total ulceration and haemorrhage

for the further testing of ulcer – healing activity, the experiments carried out are :

1. Estimation of sialic acid content – for the assessment of mucus formation which indicates cytoprotective activity.

DNA determination – It gives idea about stimulation of cell proliferation.

ECHINACEA

Synonyms

Black Sampson, cone flower purple, cone flower Brauneria

Biological Source

Echinaceae consists of dried underground parts of Echinacea purpurea or E.augustifolia or E.Pallida collected when the plant is in full bloom, fam, Asteraceae (compositae).

Geographical Source

It is perennia kherb of South Western and Central parts of United States of America especially Kansas, Arkansas, Missouri and Oklahoma. It is also found in Canada.

Macroscopic Characters

Colour : Pale brown to yellowish brown

Taste : Right in the beginning sweet followed by bitterish and giving tingling effect be the tongue.

Odour : Aromatic (mild)

Size : Rhizomes 15 mm in diameter

Roots 5 – 10 mm in diameter

Share : Roots are cylindrical slightly tapering spirally twisted.

Extra features: Rhizomes are crowned with the attachment of aerial Stems, show annulations at times. While roots are Wrinkled longitudinally and deeply furrowed, fracture is short and pliable.

Microscopic Characters

T.S.of root shows outer bark, a distinct cambium, broad xylem and central ith in the rhizome. Cork consists of multilayered thin-walled cells followed by parenchymatous cortex. Rhizome is characterized by lignified phloem-fibres in the pericycle, medullary rays are non-lignified and wide. Cells containing brown pigments and innulin in the form of spherocrystals are also seen in the parenchymatous cells.

The distinguishing characters of rhizomes of Echimacea augustifolia and that of Echinacea pellida are as under.

In E.augustifolia oleoresin canals, which are 80 – 150 μm in diameter containing yellowish orange pleo-resin, are present outside the central cylinder while lignified fibress which are 500-800 μm in length are scattered and in grous and are surrounded by phytomelanin deposition.,

E.Pallida oleo-resionous canals are present inside as well as outside thekl; cylinders whereas lignified fibres are isolated present in the kperiophery of lthe cortex and contain no phytomelanin.

Microscopy of roots of both varieties is similar.

Standards

Total ash	>	9.0 %
Acid-insoluble ash	>	3.0%
Water soluble extractives	<	15.0 %
Moisture	>	10.0%

Chemical Constituents

Echinacea species contain various types of phytochemicals, among which the polysaccharides (present in cell wall) namely arabinogalactan and two fucogalactoxyoglucans have been found to be mainly involved in immunostimulant activities. The other constitutents are echinacoside (caffeic acid glycoside), high molecular weight polysaccharide called echinacin, polyacetylene, tussilagine and isotussilagine (both pyrrolizidine alkaloids), etc.

Uses

Echinacea is used as immunostimulant, mainly for prevention or in treatment for viral infections causing colds and flu. It also acts antiseptic and peripheral vasodilator.

The polysaccharides causing immunostimulant activity are found to stimulate macrohages, by which; signal molecules namely IL-6 (interferon), IL-1 and TNF -∞ are produced. This triggers the immune system causing migration of neutrophils from bone marrow to blood stream. Stimulated

macrophages also cause phagocytosis. Although like infecting bacteria, these polysaccharides also stimulate immune system, still they are nontoxic. Echinacea has been found to be highly promising immunostimulant from nature.

POPPY SEED OIL

Synonyms : poppy oil

Biological Source

It is the fixed oil obtained from oppy seeds i.e dried seeds of Papaver somniferum, family Papaveraceae.

The seeds are collected from the poppy capsules, the fruits of opium poppy. The countries wherein opium is collected, the seeds are produced commercially.

Geographical Source

It is collected in Yugoslavia, Bulgaria, Turkey, Iran, and India and also in England.

The seeds are very small, about 1 to 1.25 mm in diameter and contain 50 – 55% of fixed oil. The seeds are expressed for production of oil

Description

Poppy oil is pale yellow coloured liquid with pleasant odour. It is a drying oil.

Standards

Specific gravity	-	0.924-0.927
Refractive Index	-	1.467 – 1.470
Acid Value	-	3.0 – 13
Lodine value	-	132 – 158
Saponification value	-	188 – 196
Hydroxyl value	-	20 – 21
Thiocyanogen value	-	77 – 78
Unsaponifiable matter	-	0.4 – 1.2%

Chemical Constituents

The oil is free of all the narcotic alkaloids of opium. The oil is rich source of linoleic acid and contains about; 73 % of it In addition, it contains palmitic (10%) arachidic (0.5%) and oleic (12%) acids.

Uses

Its taste is similar to olive and hence, used along with olive or alone in salads and also as edible oil. As iodine value is high, it is used in iodised oil, being drying oil; it is very frequently used in manufacture of varnish, soap and paints.

EUCALYPTUS OIL

Synonyms

Eucalyptus, Dinkum oil

Biological Source

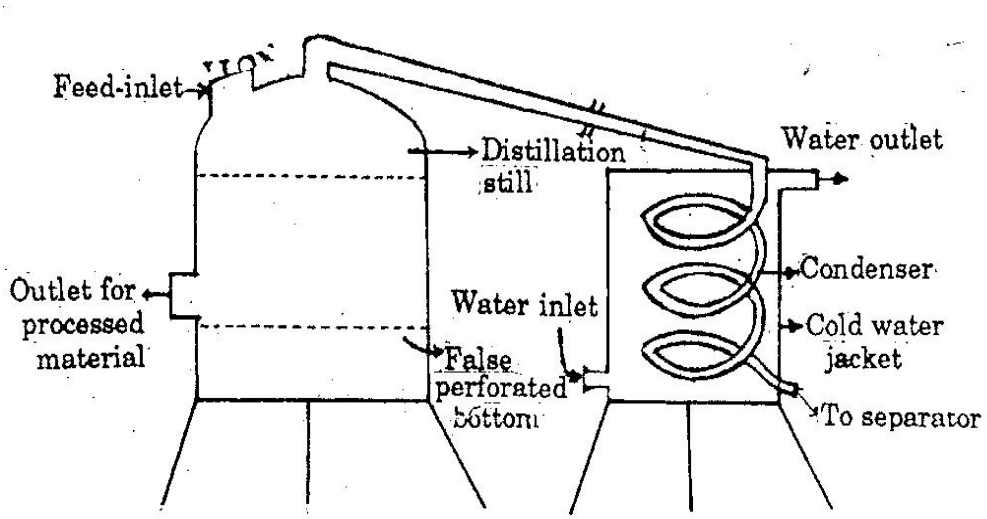
Eucalyptus oil is the volatile oil obtained by the distillation ofl the fresh leaves of Eucalytus globules and other species of Eucalyptus, belongin to family Myrtacea. It is rectified, if necessary. It should contain not less than 65% of cineole.

Source

It is indigenous to Australia and Tasmania. It is cultivated in United States (California), Spain, Portugal, and in India. E.citriodora, known as citron scentedor lemon scented gum, is grown on large scale in Kerala, Tamil Nadu and other states.

Method of Preparation

In India, the oil is commercially produced on very large scale in Nilgiris. The trees, about 16years of age are preferred for the collection of leaves. About; 750 to 1200 kg of leaves are collected per hectare. The leaves are dried in shade for about 3 days and subjected to steam distillation. The distillation unit consists of false perforated bottom and is made up of copper. Every charge for distillation consists of about 350 kg of leaves. Sufficient quantity of water is also charged in the still and the steam under ressure is passed through it. It takes about 6 hours for complete distillation. Eucalyptus oil (0.75 to 1%) produced is collected in the receiver.



The crude oil, thus produced, is rectified again after treatment with sodium hydroxide. The oil is filtered and filled in suitable containers.

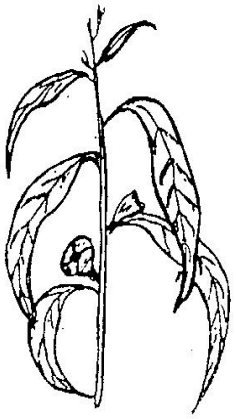
In the year 1994-1995, eucalyptus oil of Rs. 22.5 lakhs (15.3 tonnes) was exported from India.

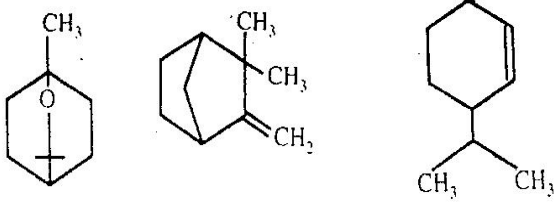
Description

Colur - It is a colourless or pale yellow liquid.

Odour- Aromatic and camphoraceous.

Taste - Pungent and camphorous followed by the sensation of cold.





It is soluble in 90% alcohol, fixed oils, fats and in paraffin It is insoluble in water.

Standards

Weight per ml	-	0897 to 0.916 g
Refractive Index	-	1.457 to 1.469
Optical rotation	-	0o to + 10o

It should be free from heavy metals and should contain only traces of phellandrene.

Chemical Constituents

Eucalyptus oil chiefly contains cineole, also known as eucalyptol (about 80%) it also contains pinene, camphene and traces of phellandrene citronellal, geranyl acetate.

Uses

Eucalyptus oil is used as a counter-irritant, an antiseptic and expectorant. It is used to relieve cough and in chronic bronchitis in the form of inhalations. It is an ingredient of several liniments and ointments solution of eucalyptus oil is used as nasal drops.

Storage Keep in well closed container away from light and in cool place.

TULSI

Synonyms

Sacred basil, Holy basil

Biological Source

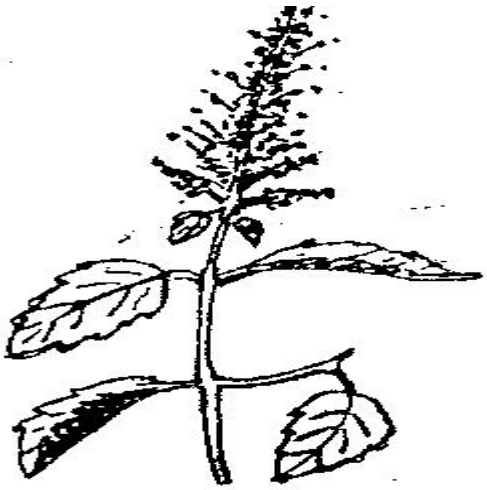
Tulsi consists of fresh and dried leaves of Ocimum sanctum Linn., *Syn. Ocimum tenuiflorum) family Labiatae.

Geogrophical Source

It is a herbaceous,much branched annual plant found throughout India, it is considered as sacred by Hindus. The plant is commonly cultivated in garden and also grown near temples. It is propagated by seeds. Tulsi, now-daya, is cultivated commercially for its volvatile oil.

Macroscopic Characters

It is much branched small herb and 30 to 75 cm in height. All parts of tusli are used in medicine, especially fresh and dried leaves. Leaves are oblong, acute with entire or serrate margin, pubescent on both sides and minutely gland-dotted. The leaves are green in colour with aromatic flavour and slightly pungent taste. Flowers are purplish in colour in the form of racemes. Nutlets are subglobose, slightly compressed, pale brown or red in colour. Seeds are reddishblack and subglobose.



Tulsi herb

Chemical Constituents

Tulsi leaves contain bright, yellow coloured and pleasant volatile oil (0.1 to 0.9%). The oil content of the drug varies depending upon the type, the place ofcultivation and season of its collection. The oil is collected by steam distillation method from the leaves and flowering tops. It contains approximately 70% eugenol, carvacrol (3%) and eugenol-methyl-ether (20%). It also contains caryophyllin. Seeds contain fixed oil with good drying properties.

The plant is also reported to contain alkaloids, glycosides, saponin, tannins, an appreciable amount of vitamin C, and traces of maleic, citric and tartaric acid.

Uses

The fresh leaves, its juice and volatile oil are used for various purposes. The oil is antibacterial and insecticdal. The leaves are used as stimulant, aromatic, anticatarrhal, spasmoytic, and diaphoretic. The jurice is used as an antiperiodic and as a constituent of several preparations for skin diseases and also to cure ear-ache. Infusion of the leaves is used as a stomachic. The drug is a good immuno-modulatory agent.

BENAFSHA

Synonym

Sweet violet

Biological Source

It consists of dried aerial parts obtained from Viola odorata Linn., lbelonging to family Violaceae.

Geographical Source

Sweet violet is indigenous to India and found in Kashmir (Kangra), Himachal Pradesh (Chamba), and Kumaon hills.

Benafsha is cultivated only in gardens. Its cultivation is also undertaken in hilly regions of North India. It grows quite satisfactorily in cool and moist climatic conditions. It does not survive on exposure to heavy rains. Its progagations can be done either by cuttings or with seeds. Drug is naturally found at an altitude of 1500 – 1800 m.

Macroscopic Characters

Benafsha is a glabrour or pubescent herb, about 15 cm in height. Its root stocks are very stout and stolons are cylindrical. Leaves are dark green, tough, broadly ovate or cordate in shape with crenate margin. They are 1.5 to 5 cm in size. Flowers are solitary, auxillary forming central flowering rosettes. Flowers are very beautiful in colour. They are deep violet in shade with bluishwhite base. Flowers are sweet, scented and hence plant is cultivated in gardens as an ornamental crop. Fruits are in the form of capsules, round, three angled and often purplish in colour. The plant blooms in second year.

The drug benafsha in the market is available in different forms, which constitute various aerial parts of plant.

1. Kashmiri benafsha - Aerial parts like stems, leaves and flowers
2. Gul-i-benafsha- Only dried flowers
3. Berg benafsha - Aerial parts without flowers

Chemical Constituents

The leaves are found to contain an essential oil, alkaloid and a colouring matter. It has a very agreeable flavour and is used for high grade perfumes. The root stocks contain saponins, a glycoside of methyl salicylate

responsible for expectorant property, and essential oil, and alkaloid odoratine. Flowers contain a substance known as violine, volatile oil, rutin and cyanin. It contains 0.1% concentrate responsible for highly pleasant odour of the drug.

Uses

The herb is used as expectorant, diaphoretic and antipyretic. The herb shows antibacterial and antifungal activities, and hence used in the treatment of eczema. It is used in the form of sarbat. The flowers are emollient, demulcent and are said to relieve pain due to cancerous growth. The leaves in large doses and seeds are cathartic. Violin is an emetic.

KAPUR KACHARI

Synonym

Spiked ginger lily

Biological Source

This consists of dried sliced rhizomes of the plant known as Hedychium spicatum, belonging to family Zingiberaceae.

Geographical Source

Kapur kachari is found in tropical and sub-tropical Asia. In India, it is found in Western and Central Himalayas at an altitude on 1000 to 2500 m.

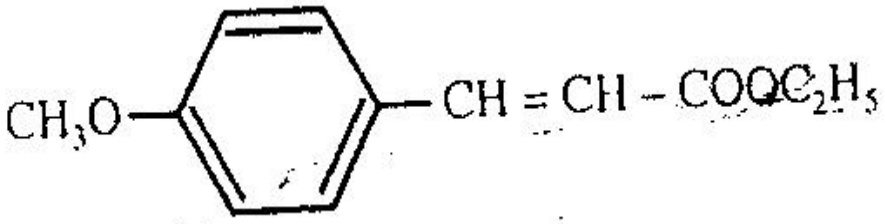
Cultivation and Collection

Ginger lily is cultivated for the ornamental foliage and agreeable sweet flowers. It is propagated by divisions of rhizomes. It needs rich loamy soil with plenty of water. Kapur kachari is grown in gardens as a potted plant. It thrives well in semi-shady situation. It is perennial herb, about 1 m in height with glabrous leaves and white ascending flowers, found in the form of dense terminal spikes.

Macroscopic Characters

Colour - Rhizomes are white and starchy internally, while rough and Reddishbrown externally.

Odour	-	Very strong aromatic
Taste	-	Camphoraceous, bitter.
Size	-	1.5 to 2 cm in diameter and about 0.5 cm in thickness. The slices are covered with occasional rootlets.
Shape	-	They are flant and spherical.



Chemical Constituents

Kapu Kachai rhizomes contain 4% of volatile oil, 52% of starh, glyosidal organi acid and ash (4.5%). The volatile oil is responsible for flavour of the drug and hiefly contains paramethoxycinnamic acid ester (about 68%). It also contains cineole limonene, 8-Caryo-phyllene, ethyl cinnamate, and traces of cinnamic adehyde.

Uses

Rhizomes are used as stomachic, stimulant, carminative and tonic. They are either used in the form of powder or decoction. Being aromatic, it is used as favouring agent forseveral cosmetic preparations and also to flavour tobacco. The rhizomes are used in preparation of 'abit', a fragrant highly perfumed powder used during the religious functions. It is also known to possess insect repellant properties.

Storage

Rhizomes are thoroughly dried and stored in well closed containers.

CLOVE

Synonyms

Caryophyllum Clove flower Clove buds.

Biological Source

Clove consists of dried flower buds of Eugenia caryophyllus, family Myrtaceae. It should contain not less than 15% (v/w) of clove oil.

Geographical Source

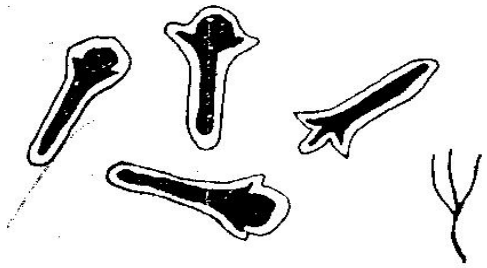
It is indigenous to Amboyna and Molucca islands. It is now cultivated cultivated chiefly in Zanzibar, Pemba, Penang, Madagascar, Caribbean islands, Sri Lanka and India, cloves are grown in Nilgiri, Tenkasi-hills and in Kanyakumari district of Taiml Nadu state. It is also cultivated in Kottayam and Quilon districts of Kerala.

Cultivation and Collection

Deep rich loamy soil with hums content is suitable for clove cultivation. It is also found growing favourably in open sandy loam and laterite soils of South Kerala region. Water logging of soil must be avoided. It need warm humid climate and grows well in the vicinity of sea.

The annual rainfall in the range of 150 to 250 cm in another requirement for the cultivation of clove. Clove thrives best in the locations ranging from sea level upto 900 m. It is propagated by seed germination. The seeds are sown from August to October. The seeds are placed in the nursery beds at a distance of 10 cm. It takes from four to five weeks for seed germination. The seedlings of clove are slender and delicate, with poor growing rate. After six months, they are transplanted to the pots where they are allowed to grow for a year. Thereafter, they are again transferred to the field and are provided with the shade in initial stages of growth. Clove can also be grown with arecanut, coconut or nutmeg plants. The plants are provided with suitable fertilizers like ammonium sulphate, super phosphate and potash. Generally, the fertilizers are given in two doses; first in May/June and Second in October. The plant starts bearing after 7 to 8 years and a satisfactory yield per hectare of the drug is achieved only after 15 to 20 years of growth. Under normal condition of soil, clove tree produces on an average, 3kg of the drug. Cloves are handpicked or collected by beating with bamboos. This operation commences when the cloves Start changing their colour from green to slightly pink, when the tree is tall land cloves are beyond reach, platform ladders are used for collection. The cloves are dired in the sun and freed from

foreign material and graded the cloves on drying become percfectly crimson or brownish-black in colour.



Apart from cloves and clove powder as spices, india exported 4.8 tonnes of clove oil costing approximately Rs. 20 lakhs during 1994-95, and clove oleoresins of Rs. 25 lakhs.

Macroscopic Characters

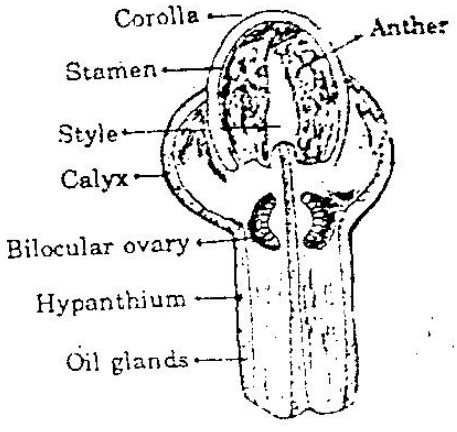
Colour - Crimsom to dark brown

Odour - Slightly aromatic

Taste - Pungent and aromatic followed by numbness

Size - About 10 to 17.5 mm in length, 4mm in width, and 2 mm thick

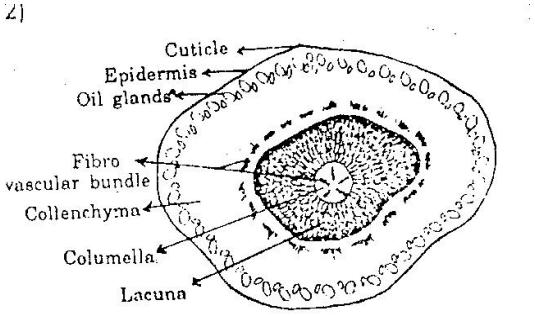
Shape - Hypanthium is surmounted with 4 thick acute divergent sepals surrounded by dome shaped corolla. The corolla consists of unexpanded membranous petals with several stamens and single stiff prominent style. Cloves are heavier then water.



L.S. of Clove

Microscopic Characters

The epidermis of the clove is covered with thick cuticle. The epidermis itself consists of straight walled cells and large anomocytic stomata. The oil glands, which are ovoid and schizolysigenous are found in all parts of the drug. Phloem fibres, which are isolated, are occasionally found in the spongy tissue. Cluster crystals of calcium oxalate and small number of stone cells are found in the drug. Clove does not contain starch.



Chemical Constituents

Clove contains about 15 to 20% of volatile oil; 10% to 13% of tannin (gallotannic acid), resin, chromone and eugenin. The volatile oil of the drug contains eugenol (about 70 to 90%) eugenol acetate, caryophyllenes and small quantities of esters, ketones and alcohols

Oil of clove is colourless to pale yellow in colour. It becomes thick and darker in colour on storage. It has specific gravity of 1.038 – 1.06, refractive index of 1.527 to 1.535 and it boils at 250oC

Chemical Test

If the transverse section of clove is treated with strong potassium hydroxide solution, the needle shaped crystals of potassium eugenate are observed.

Uses

Clove is used as dental analgesic, carminative, stimulant, flavouring agent, an aromatic and antiseptic. It is also used in the preparation of cigarettes. The oil is used in perfumery and also in the manufacture of vanillin.

Ginger

Synonyms

Zingiber; Zingiberis

Biological Source

Ginger consists of rhizomesl of Zingiber officinale Roscoe, family Zingiberaceae, scrapped to remove the outer skin and dried in the sun. It is known as Jamaica ginger in the market.

Geographical Source

It is said to be native of South East Asia, but is cultivated in Caribbean islands, Africa, Australia, Mauritius, Jamaica, Taiwan and India. More than 35% of the world's production is from India.

Cultivation and Collection

Approximately, 25,000 hectares of land is under cultivation in India for the production of about 25,000 tonnes of dry ginger annually. In almost all states of India, ginger is cultivated, especially in Kerala, Assam, Himachal Pradesh, Orissa, West Bengal and Karnataka. Giner needs warm humind climate and is cultivated in areas with heavy rainfall. It is cultivated even at sea level, but still it thrives best at an altitude of 1000 to 1500m. If no sufficient rainfall is available, proper arrangements for irrigation are necessary. Sandy or clay or red loamy soils are suitables for finger. Ginger is cultivated by sowing rhizomes in the month of June. Carefully preserved seed-rhizomes are cut into small pieces and, at least one living bud is allowed in each piece About 1200 to 1400 kg ginger seed-rhizomes are necessary per hectare. Ginger is soil exhausting crop and being arhizome, needs to be supplemented with good quantity of manures and fertilizers. Superhposphate, ammonium sulphate and potash are the common fertilizers used for giner. Ginger is ready for lharvesting in about six months, when its leaves become yellow. Harvesting of ginger is done by digging the rhizomes. They are washed properly and the dried to improve the colour and to prevent its further growth. The rhizomes are scrapped, dried and coated with inert material like calcium sulphate. The yield of 1500 kg per hectare of green ginger is possible by cultivation.

Ginger is produced in almost all the states of india and ranks first among giner producing countries of the world. There are one dozen large scale oleo resin producing industries in india at present with total installed capacity of 900 tonnes. In 1988-89,404.8 tonnes of spice oleo-resins were exported during 1995-1996. Most of the exports are to U.S., U.K., France, West Germany, Netherlands and Yugoslavia. Exports of ginger oil during 1994-95 and 1995-96 were 81.0 lakhs and 142 lakhs respectively.

Macroscopic Characters

Colour - Externally, it is buff coloured.

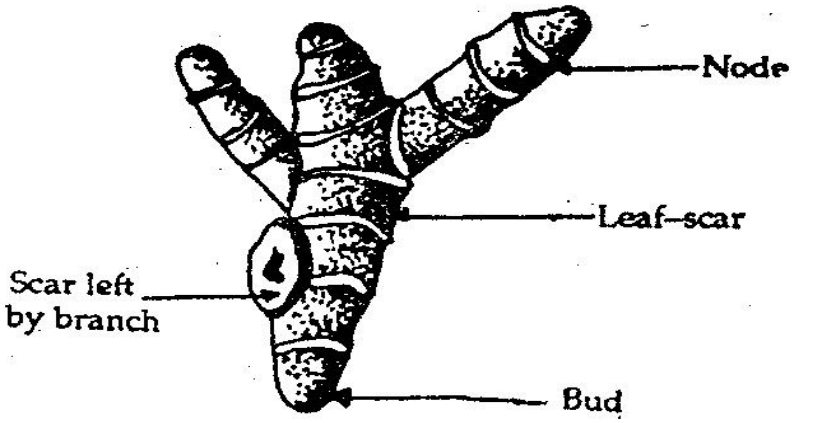
Odour - Agreeable and aromatic.

Taste - Agreeable and pungent.

Size - Rhizomes of ginger are about 5 to 1.5*1.5 to 6.5 cm.

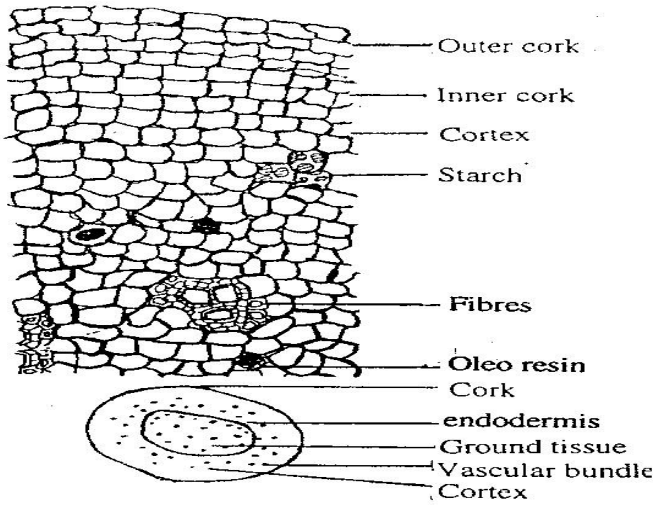
Shape - The rhizomes are laterally compressed, bearing short flat, ovate and oblique branches on the upper side, with bud at the apex.

Fracture - Short and fibrous.



Extra Features

Longitudinal striations and the occasional projecting fibres are present on the surface of ginger. Trasnsversely cut surfaces shows well marked endodermis and stele.



Microscopic Characters

Cork consists of irregularly arranged cells, followed by cortex. Cortex is made up of thin walled parenchymatous tissue. Well marked endodermis

distinguishes the stele and the cortex. Cortical tissue encloses several closed collateral fibro-vascular bundles. Vascular bundles just inside the endodermis are free of fibres. Oleo-resinous cells and starch grains are found throughout the ground tissue. Endodermis is free of starch.

Chemical Constituents

Ginger consists of volatile oil (1 – 4%), starch (40 – 60%), fat (10%), fibre(5%), inorganic material (6%), residual moisture (10%) and acrid resinous matter (5 – 8%). Ginger oil is constituted of monoterpene hydrocasrbons, sesquiterpene hydrocarbons, oxygenated mono and sesquiterpenes, and phenyl propanoids.

Sesquiterpene hydrocarbon content of all types of ginger oil from different countries is found to be same and includes α-zingiberene, β-bisabolene, α-farnesene, β-sesquiphellandrene and α-curcumene.

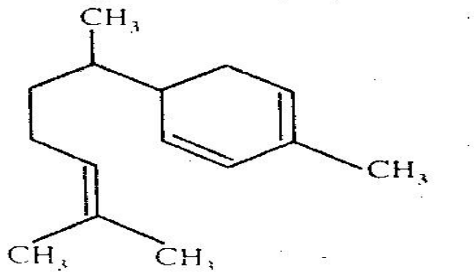
Aroma and flavour are the main characters of ginger. Aroma is due to fragrant principles of volatile oil while the flavour, pungency and pharmacological action is exerted by phenolic ketones of oleoresin. Various components of volatile oil like isometric terpenic aldehydes like geranial and citral, which cause the delicate and lemony aroma. Few sesquiterpene oil hydrocarbons are believed to exert spicy note.

Phenolic ketones of oleo resin include gingerols like shogaols, zingerone, paradols, gingediols, hexahydrocurcumin and also O-methyl ether of these compounds.

Standards

FOM	- not more 2.0%
Water soluble extractive	- not less than 10%
Alcohol (90%) soluble extractive	- not less than 4.5%
Total ash	- not more than 6.0%
Water soluble ash	- not less than 1.7%
Acid insoluble ash	- not more than 2.0%

gerone, paradols, gingediols,



Zingiberene

Uses

Ginger is used as a stomachic, an aromatic, a carminative, stimulant and flavouring agent. Ginger oil is used in mouth washes, ginger beverages and liquors.

Ginger powder has been reported to be effective in motion sickness. It has been suggested that absorbent, aromatic and carminative properties of ginger on G.I. tract cause adsorption of toxins and acid enhanced gastric motility. These may have probably blocking effects of G.I. reactions and nausea.

Z.officinale (Methanolic extract) has molluscicidal effects, possessing efficacy to control the parasitic infection viz schistosomiasis. U.S. food and Drug administration has included ginger as product that is generally regarded as safe (GRAS).

Storage

Ginger is coated with lime to improve its colour and quality and hence this particular is known as limed ginger.

Adulterants

Ginger is adulterated with exhausted ginger, but it can be detected by determination of water-soluble ash, volatile oil content and alcohol and water soluble extractives.

GINGER OLEO-RESIN

Synonym

Gingerin

Biological Source

It is the oleo-resin obtained by percolatin the powdered rhizomes of Zingiber officinale (Zingiberaceae).

Method of Preparation

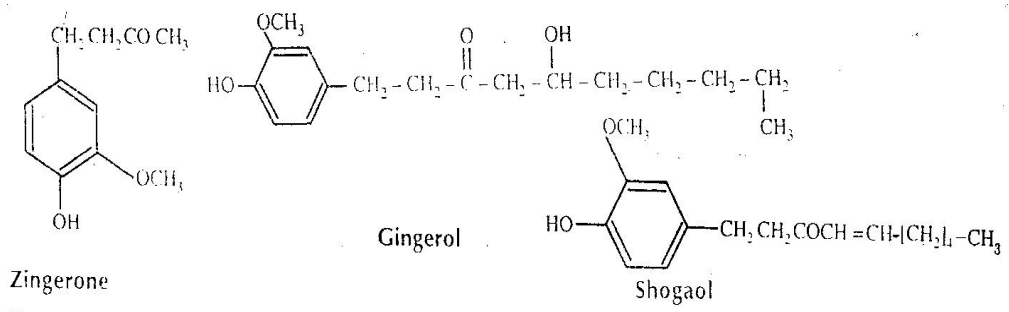
Coarsely powdered dried ginger is extracted with acetone or ethyl ether or ethylene dichloride by percolation method. The drug is extracted until exhausted and the extracts are mixed together. The solvents is removesd by distillation under reduced pressure. Alcohol gives the maximum yield of oleo-resin. The yield of gingerin may vary from 3.5 to 9.0%, depending upon the source of the material and the method of preparation. An average yield of oleo resin is 6.5%.

Description

It is dark brown, aromatic and pungent viscous liquid.

Chemical Constituents

Gingerin contains approximately 18 – 35% of volatile oil of ginger. It contains pungent, as well as, non-pungent principles of ginger. Fresh samples of gingerin may contain 30.0% of gingerol (the main pungent substance of ginger), shogaol and zingerone.



Uses

Since the oleo-resin can be standardized, it is prepared in industry for its desired use. Oleo-resin of gingers is mainly used as flavour for carbonated beverages in the spices and condiments.

Indian export of ginger oleo-resin during 1996-97 was found to be Rs.451 lakhs.

TURMERIC

Synonyms

India saffron, Curcuma

Biological Source

Tumeric consists of dried, as well as, fresh rhizomes of the plant known as Curcuma longa Linn.(C.domestica), belonging to family Zingiberaceae. It contains not less than 4% of volatile oil.

Geographical Source

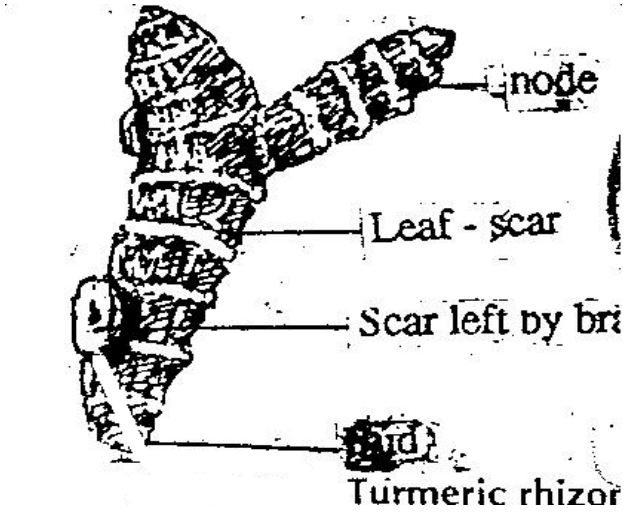
India accounts for as much as, 90% of the total output of the world. Tamill Nadu and Andhra Apradesh together contribute about 70% of the Indian production. Kerala also produces large quantity of turmeric. It is very superior in quality and is exported on large scale. At present, about 1,07,800 hectasres of land is under cultivation of turmeric with 2,94,900 tonnes of production. In the year 1996-97, India exported 155 tonnes of turmeric-oleo resing of the value of Rs. 868 lakhs.

Curcuma is a genus of about 70 species of rhizomatous herbs distributed in south East Asia and especially india, china, Thailand,Italy,Malaysia, Archipelago and N.Australia. Commercially, C.amada, C.angustifolia, C. aromatica, C.caesia, C.zedoaria and C.longa ares important. Out of these, C.longa (turmeric) is more important due to its uses like spice, condiment, antiseptic in bruises, anti-inflammatory and in sprains. It has long been known traditionally as a natural dye-stuff for dyeing wool and silk. Most of the species arse perennial herbs which grow 2 – 3 ft. high with a short stem and tufted leaves. Rhizome is the product of commerce.

Cultivation and Collection

C.long (turmeric) is the main species of commerce and is cultivated for its rhizomes in india, China and also in Sri Lanka, Indonesia, Jamaica, Peru.India is the major grower with almost 80,000 hectares under this crop producing 1,44,000 tonnes per annum. In 1994-95, it exported 289,200 tonnes of turmeric worth India Rs. 44.59 crores. The plants are grown for 7 to 9 months after which the rhizomes (both mother and finger) are harvested, cooked, dried and then processed for powder, oleo-resin and curcumin. The extraction of powder is carried out by using solvents, water or both. Diseases and insects are known for which proper methods of control are available. Genetic improvements have been attempted and five high yielding varieties have been developed. High yielding curcumin varieties have been evolved through tissue culture techniques; clonal propagation has been successfully developed in case of C. longs.

Macroscopic Characters



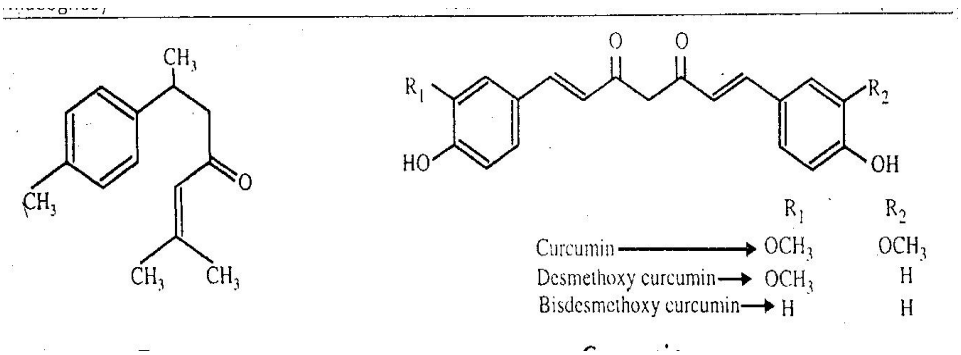
Externally, the drug is yellowish-brown in colour with characteristic odour and slightly bitter taste. Round turmeric rhizome are oblong, while long variety is cylindrical and short branched. Root scars and annulaions are present. The fracture is horny and internal surface is orange.

Microscopic Chasracters

The trasnsverse section of turmeric rhizome shows theoutermost 4 to 6 layers of brick shaped parenchymastous cork, followed by cork cambium. The cortex consists of thin walled rounded pasrenchymastouscells containing scattered vasculasr bundles. Oleo-resin cells with brownish contents are also observed throughout the ground tissue. Endodermis is well marked and starch grains (5 to 15 in diameter) are abundant.

Chemical Constituents

Turmeric contins about 5% of volatile oil, resin, and abundant zingiberaceous starch grains and yellow colouring substances known as curcuminoids. The chief component of curcuminoids is known as curcumin (50-60%). Chemically, curcuma species contain volatile oil, starch and curcumin. Curcumin and other relatedcrucuminoids are reportated to beresponsible for the yellow colour in some species. Volatile oil content ranges from 1to 6.5% and composed of mono and sesquiterpenes such as αand β pinene, α-phellandrene, camphor, camphene zingiberene andα, β curcumenes. Species like C.angustifolia and C.caulina have high starch content and are used as a substitute for arrow root. Chemical constituents are known to vary as per geographical locations and curcumin content is reported to vary from 1 to 10%.



Standards

Foreign organic matter	- not more than 2.0%
Ash	- not more than 8.0%
Water soluble extractive	- not more than 9.0%
Alcohol-soluble extractive	- not less than 10.0%
Moisture	- not more than 100%

Chemical Tests

1. Powdered drug with sulphuric acid gives crimson colour.
2. The aqueous solution of turmeric with boric acid gives reddish-brown colour which on addition of alkali changes to greenish-blue
3. With acetic anhydride and concentrated sulphuric acid, it gives violet colour. When this test is observed under ultraviolet light, red fluorescence is seen.

Uses

Turmeric is used as a condiment or spice, and colouring agent, especially for ointments and creams. Chemically, it is used for the detection of boric acid.

Turmeric/curcumin is official in various pharmacopoeias. Apart from traditional uses, curcumin has been proved as anti-inflammatory drug. Antiasrthritic agent has been isolated from C.aromatica in China C.wenyjuin(C.aromatica) has been used in cervical cancer. Curcumin has been defined by International Standards Organisation (ISO 5562-1983) and British Standards (BS 6147 : 1983). It is estimated both by colorimetry and HPLC. G.L.C., and T.L.C. methods are also reported for various constituents. 30th report of WHO/FAO expert committee on food additives has included curcumin.

Substitute

Curcuma amada Roxb is a common substitute for turmeric. It is found wild Lin Andhra Pradesh, Orissa and West Bengal.

RAUWOLFIA

Synonyms: Rauwolfia root; Serpentia root; Chhotachand, Sarpagandha.

Biological Source

Rauwolfia consists of dried roots of the plant known as Rauwolfia serpentina Benth, belonging to family Apocynaceae. It is collected in autumn from 3 to 4 years old plant along with the bark. It contains not less than 0.14% of alkaloids, calculated as reseprine. Rauwolfia refers to the name of scientist Dr. Rauwolf and serpentina refers to snake like structure of root.

Geographical Source

Several species of Rasuwolfia are found distributed in the tropical of Asia, America and Africa. Commercially, it is produced in Uttar Pradesh, Bihar, Orissa, Tamil Nadu, West Bengal, Karnataka, Maharashtra, and Gujarat.

History

This drug is known to Indian Systme of Medicine since last many centuries. Becase of snake like shape of the drug, it has been known as ‘ Sarpagandha’. It has found its place as an important drug in treatment of insanity. And snake bite since traditional times. But the drug came into limelight only after the isolation of reserpine, its most significant alkaloid, in 1952 by Mueller. Since then a large interest has been generated regarding the activity of this drug.

Cultivation and Collection

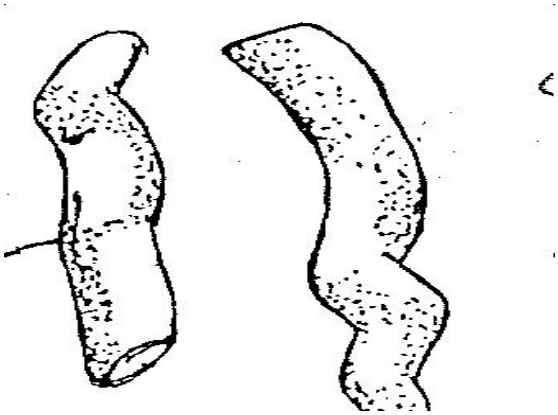
Under wide range of climatic condition, rauwolfia grows luxuriantly. However, it flourishes in hot humid condition and grows satisfactorily in shade. In wild state, it grows in variety of soils. But for cultivation, clay loamy soil with large amount of humus and good drainage are supposed to be ideal. The pH of the soil should be acidic and around 4. The temperature range for cultivation is 10oc to 38oc. Rainfall should be in the range of 250 – 500cm. Soils containing large amount of sand make the plants more susceptible to diseases.

In can be propagated by various methods, such as by seeds, roots, cutting, root stumps, etc. The propagation from seeds is usually the method of choice. The healthy seeds into the nursery beds. The rate of germination of seeds is very low, hence sufficient quantity of the seeds are sown. Sowing is done in the month of May or at the break of monsoon. The seedling are then transplanted in the month of August at a distance of 16 to 30 cm. The plant are provided with various chemical fertilizers and manures. The chemical fertilizers ammonium sulphate, urea; while the manures include, generally, the bone-meal. The plants are kept free from weeds. When the plants ares about 3

to 4 years old, they are uprooted. The roots are cut properly, washed so as to remove the earthy matter 4 years old, they are uprooted. The roots arse properly, washed so as to remove the earthy matter and dried in air.

It needs about 5 kg of seeds to produce the seedlings to cover the area of one hectare after transplantation. The average yield of roots per hectare is 1200kg. It may vary, depending upon the soil, climatic conditions and age of the plant.

Macroscopic Characters



Colour - Root bark is grayish yellow to brown and wood, pale yellow.

Odour - Odourless

Taste - Bitter

Size - About 10 to 18 cm long and from 1 to 3 cm in diameter.

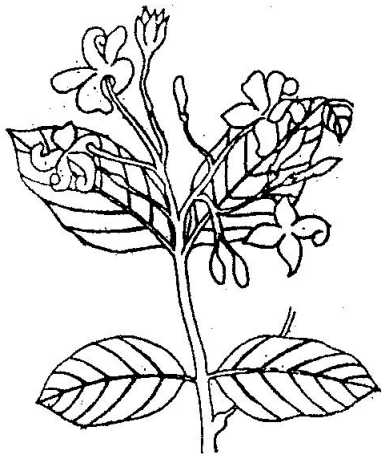
Shape - Roots are sub-cylindrical, slightly tapering, tortuous.

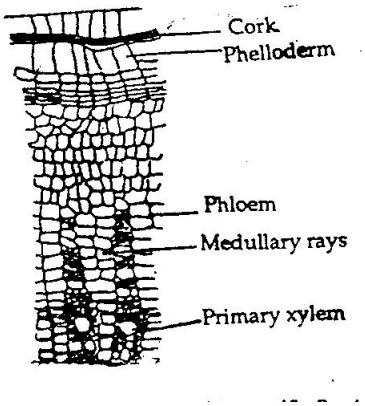
Fracture is short and irregular. The transversely cut surface is white, dense with finely radiation xylem.

Extra Features

Roots are rough with longitudinal marking and slightly wrinkled surface. Rootlets are usually absent, but few small circular root scars with tetrastichous arrangements are seen.

Microscopic Characters

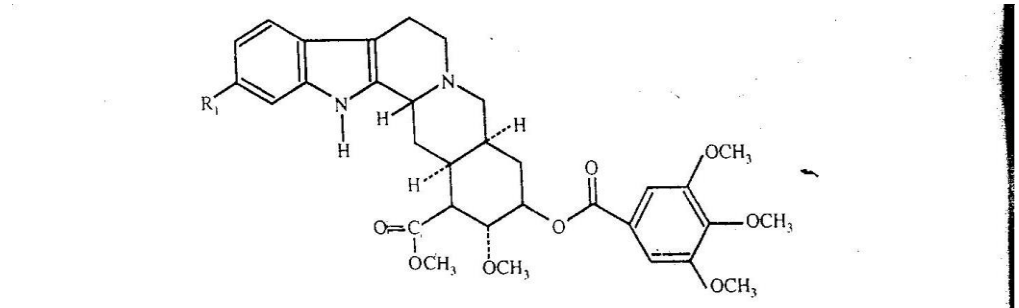




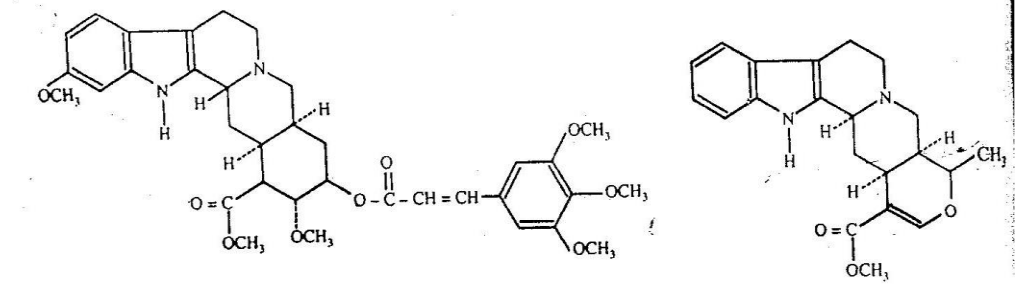
The cork is made up of stratified cells followed by phelloderm of few rows of parenchyma. Phloem is narrow, parenchymatous with small scattered sieve tissue. Parenchyma contains starch grains and few latex cells, with brown resinous matter. Secondary phloem contains calcium oxalate crystals. Xylem is about 4/5 th of the diameter of the root and consists of vessels, tracheids, wood parenchyma and wood fibres. Xylem vessels are elongated upto 350μ in length and 50μ in which and contain simple or bordered pits. Stone cells and phloem fibres are absent.

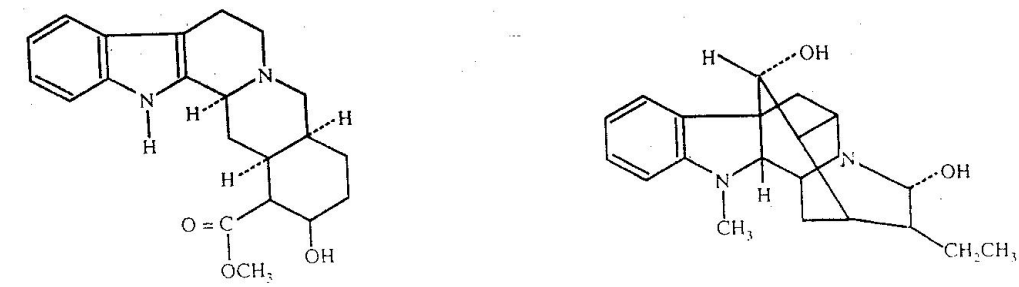
Chemical Constituents

About 30 indole alkaloids have been reported in drug and total alkaloidal content of rauwolfia roots ranges from 0.7 to 3%, depending upon the source. Alkaloids are concentrated mostly in the bark of the roots. The alkaloids of rauwolfia are broadly classified into the following types, (1) indole alkaloids, (2) indoline alkaloids, (3) indolenine alkaloids, (4) oxyindole alkaloids and (5) pseudo indoxyl alkaloids. The important alkaloid of rauwolfia is reserpine. Apart from the alkaloids, it also contains oleo-resin, phytosterol, fatty acids, alcohol and sugars. The other alkaloids present in the drug are ajmaline, ajmalicine, rauwolfinine, rescinnamine, reserpinine, yohimbine, serpentine and serpentinine. The major alkaloids reserpine and rescinnamine are esters derived from methyl reserpate and trimethoxybenzoic acid in reserpine and trimethoxycinnamic acid in case of rescinnamine. Syrosingopine is methyl carbethoxy syringoyl reserpate.

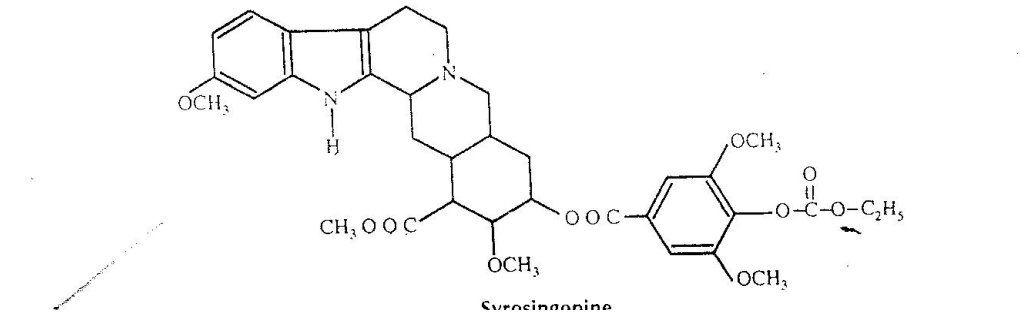


Reserpine $R_1 = OCH_3$ Deserpidine $R_1 = H$





Yohimbine Ajmaline



Syrosingopine

Reserpine like alkaloids like alkaloids are colorimetrically determined by reaction between acidic solution of alkaloids and sodium nitrite.

Chemical Tests

(1) A red coloration along the medullary rays is observed when the freshly fractured surface is treated with concentrated nitric acid.

(2) Reserpine shows violet red colour when treated with solution of vanillin in acetic acid.

Uses

Rauwolfia is antihypertensive in activity. Among the various alkaloids rauwolfia, reserpine, rescinnamine and ajmalicine are clinically important. Reserpine loweres the blood pressure by depleting stores of catecholamines at nerve endings. It prevents re-uptake of nor epinephrine at storage sites, allowing enzymatic destruction of neuronal transmitter. It is used to treat mild essential hypertension and may be an effective adjunct to the treatment of more severe hypertension.

Because of the tranquillising effects, the drug is used in mild anxiety conditions and reserpine in some of the neuropsychiatric disorders.

Rescinnamine is also used as antihypertensive, but it causes mental depression in higher doses.

Deserpidine is used as antihypertensive, but it causes mental depression in higher doses.

Deserpidine is used as antihypertensive and tranquilliser. It shows very less side effects.

Ajmalicine, though less in quantity, has the uses in treatment of circulatory diseases, in relief of obstruction of normal cerebral blood flow.

Syrosingopine shows peripheral effects similar to reserpine. It has less sedative actions and it is used for the treatment of mild or moderate hypertension.

Dose

Raswolfia	:	100 to 150 mg (oral twice daily).
Reserpine	:	initial dose 250 μg once a day (oral), Maintenance dose 100 – 250μg once a day.
Rescinnamine	:	500μg oral twice a day (initial dose);250μg oral daily Maintenance dose.

Allied Drugs and Substitutes

The rauwolfia species are not limited only to South East Asian region, but also found in Africa, Central and South America, New Guinea, Hawaii, New Caledonia, Australia and far east regions. It is reported that reuwolfia has about 86 different species. From the medicinal point, the most pertinent to mention here is R. vomitoria, which is known as African rauwolfia. It is used as a commercial source for the preparation of reserpine. The other known

species of rauwolfia from Africa are R. caffra, R. cumminsfi, R.mombasiana, R.oreogiton, R.rosea and R.volkensii. All of them contain reserpine.

The other rauwolfia species with reserpine content are R. tetraphylla and R. nitida. Catharanthus roses contain ajmalicine.

Pausinystalia yohimba, known as yohimbe bark, contains yohimbine, which is structurally related to reserpine.

The root bark of Alstonia venenata and A.constricta also contain reserpine. The various species of Aspidosperma genus contain indole alkaloids which resemble to those from rauwolfia.

The various other species with whichrauwolfia is found to be substituted are Rauwolfia tetraphylla, R. densiflora and R. vomitoria (African rauwolfia). R.densiflora contins sclersenchyma, while R. tetraphylla has uniform cork, abundant sclereids and fibres, but devoid of rescinnamine. The root of R. vomitoria has 5 discontinued bands of sclerenchyma and very large vessels.

CINCHONA

Synonyms: Jesuit's bark, Peruvian bark

Biological Source

It is the dried bark of the cultivated trees of Cinchona calisaya wedd., C.ledgeriana Moens, C.officinalis Linn., C.succirubra Pav. Ex-klotzsch, or of hybrids of either of the last two species with either of the first two. Cinchona belongs to family Rubiaceae. It contains not less than 6 per cent of total alkaloids of cinchona.

Geograsphical Source

India, Bolivia, Columbia, Ecuador, Peru, Tanzania, Guatemala, Indonesia and Sri Lanka are the countries where cinchona is found. In india, it is cultivated in Annamalai hills (Coimbatore district) and Nilgiri hills (Nilgiri district) in Taiml nadu and in Darjeeling area of West Bengal.

History

Cinchona is native to Eastern slopes of the Andes at high altitudes (1500 – 2500 metres). It is known that the bark was first used as an antipyretic in 1630 by Jesuits, although it was discovered in 1513 in Peru. Owing to the efforts of Viceroy of Peru, Count Chinchon it was introduced as a drug in Europe around 1655, it was officially reported as an infusion in London Pharmacopoeia in 1677. in the honour of viceroy, the genus was described by Linnaeus as Cinchona in 1742. After the isolation of quinine and cinchornine in 1820 by Pelletier and Canventon, the alkaloids or their mixtures came into use as a medicine. In 1960, C. calisaya, C. micrantha and C. succirubra were

introduced in india by Markham. Dutch, introduced C. ledgeriana in java and sooner the country became world's most important source for this drug with a high alkaloidal content. In india, owing to the antimalarial and antipyretic use of this drug; right from 1880, a large area was taken for cultivation of cinchona in West Bengal, which eventually shifted to south india.

Cultivation, Collection and Preparation

Most of the cinchona species profusely grow in sub-tropical or tropical climates at a height of about 1000 – 3000 metres. The trees, growing below this height are found to have less percentage of quinine. The rainfall conditions required are uniform (from 250 – 380 cm in a year). The favourable growth is achieved between an atmospheric temperature of 60^{o} – 75^{o}F. Cinchona requires light, well drained forest soil which is rich in organic matter. The acidic soil having a pH of 4.2 – 5.6 and a small amount of mitrogen are found to be most favourable for growth. Cinchona needs slopping situation, high humidity and protection from wind.

The propagation is done with either seeds or budding or layering. In West Bengal, only budding is practiced and in Tamil Nadu, the budding and layering methods are applied. The seeds of cinchona are very small and light in weight. About one gramme of cinchona seeds contain 3500 seeds. The are admixed with soil during sowing. The maintenance of genetic purity causes a problem as high cross fertilization occurs in cinchona plants. This affects the yield, like in high alkaloid content giving species, such as C.ledgeriana, the average alkaloid content is reduced. The germination takes place in 3 – 6 weeks. The seedlings with 2 pairs of leaves are transplanted and space of 6 – 10 cm is maintained in between two seedlings and 2 rows. The young seedlings are protected from direct sunlight. In forest soil, they are transplanted after 15 months of growth and preferably before heavy rain fall. A distance of 2 x 2 metres is maintained between two plants. As cinchona consists of stem, as well as root bark, the plants from 4 to 20 years of age are selected for harvesting, but the maximum alkaloidal content is found to 6 to 10 years old plants. The bark is collected by coppicing method. For this purpose, vertical incisions are made on branches, trunk of tree and these incisions are connected by horizontal circles. The bark is then stripped off and dried in sun light and further by artificial heat. The drying is done below 175^{o}F. During drying, the bark loses upto 70 per cent of its weight. The care should be taken to avoid molding or fermentation during drying. The quills of drug are packed in gunny bags and marketed, The root bark is collected by uprooting the trees and bark is separated manually.

During the two world wars, Java and Indonesia lost their positions as potential producers of cinchona. After that, India has gained the prime position as producer and supplier of cinchona and quinine. By 1985 –m 86, the production had reached upto 10 lakh kg of bark and about 26,000 kg of quinine salts.

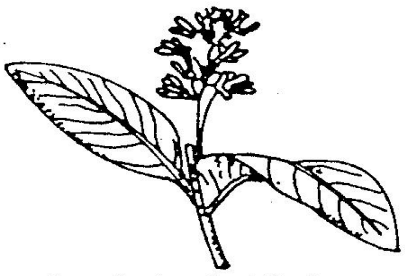
India exported quinine and its salts of Rs.299.0 lakhs during 1995 – 96.

Extraction of Quinine.

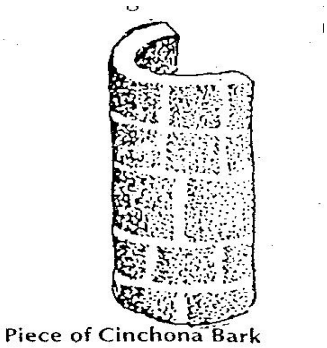
For extraction of quinine, the bark is powdered and extracted with benzene or toluene in presence of alkali, Further, the alkaloids are extracted with dil, sulphuric acid. By bringing the acid extract to neutrality, quinine sulphate separates, as it is sparingly soluble.

Macroscopic Characters.

Cinchona bark has a slight and characteristic odour, but somewhat astringent and intensely bitter taste. In general, the bark is available in the form of quills and curved pieces.



Flowering bunch of Cinchona



Piece of Cinchona Bark

Stem bark: It is upto 30 cm in length and about 2 to 6 mm in thickness. The outer surface shows dull brown grey or grey colour and many a time, shows presence of mosses and lichens owing to its growth in heavy rainfall areas. The bark is rough and has transverse fissures. These fissures are different in different species. It is furrowed or wrinkled longitudinally. The outer bark in some varieties shows exfoliation. The inner, surface is pale yellowish-brown to deep reddish-brown and the colour depends on the species. The fracture is short in external layers and fibrous in the inner portion.

Root bark: It occurs in length of 2 – 7 cm. The bark is curved, twisted or irregularly channelled. The outer and inner surfaces are similar in colour. The outer surface is scaly and shows depressions. The inner surface is striated.

The different commercial varieties have some special characters. C. succirubra is also called as red bark, whild C. ledgeriana is referred to as yellow bark. C.robusta is the hybrid between C.succirubra and C.officinalis.

The typical characters of 4 main species of cinchona

Characters	C.calisaya	C.ledgeriana	C.officinalis	C.Succirubra
Size	Diameter is from 12-25 mm and thickness from 2-5mm	Diameter is 12-25mm and thickness varies from 2-5mm	Diameter is upto 12mm and thickness is upto 1.5 mm	Diameter is from 20-40 mm and thickness from 2-5mm
Other Features	Broad longitudinal fissure with trans-longitudinal Verse cracks.	Broad longitudinal fissures and cracks more in number, but less deep. Some pieces shows longitudinal wrinkles and reddish warts.	It shows a number of transverse cracks cracks wrinkles, but less number of tansvese cacks. Only some pieces show reddishwards.	Well marked
Powder	Cinnamon brown	Cinnamon brown	yellow	Reddish brown

Microscopic Characters

Cinchona exhibits the typical histological characters of the bark. The cork cells are thin-walled, followed by phelloderm. The cortex consists of several secretory channels and phloem fibres. Medullary rays with radially arranged cells are present. Idioblast of calcium oxalate is the specific characteristic of cinchona bark. Starch grains ares present in the parenchymatous tissues. Stone cells lare rarely present in the structure. A few of the cork cells are lignified. Medullary rays are 2 to 3 cells wide.

Chemical Constituents

Cinchona bark contains about 25 alkaloids, which belong to quinoline group. The important alkaloids are quinine, quinidine, cinchonine and cinchonidine. The alkaloids of lesser importance are quinicine, cinchonicine

hydroquinine, hydrocinchonidine and homocinchonidine. C. succirubra contains 5- 7% of total alkaloids, of which 30% is quinine. C.ledgeriana yields from 6 – 10% and ,in some cases, upto 14% of total alkaloids, with upto 75% is quinine. C.salisaya has 6 – 8% total alkaloids (about 50% quinine).

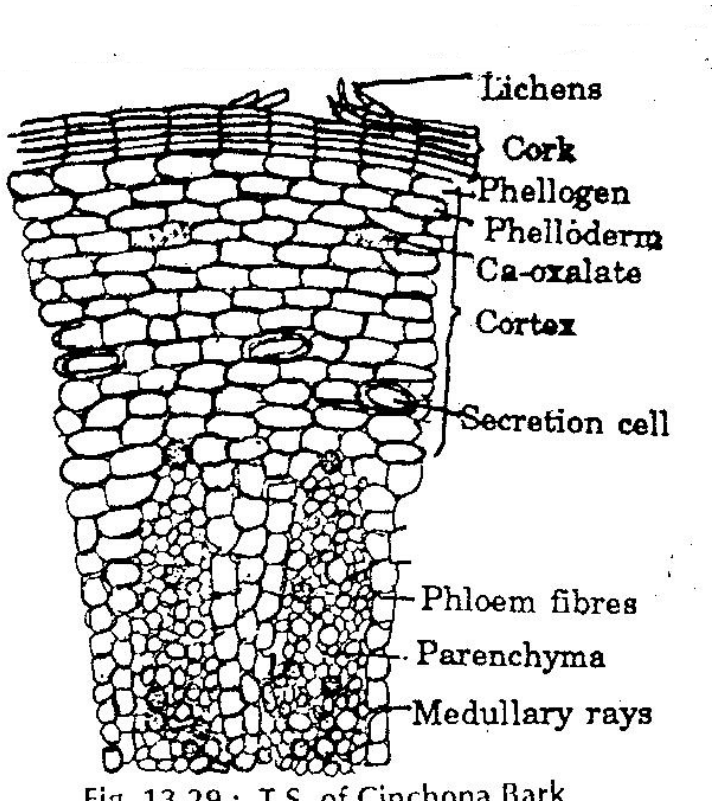
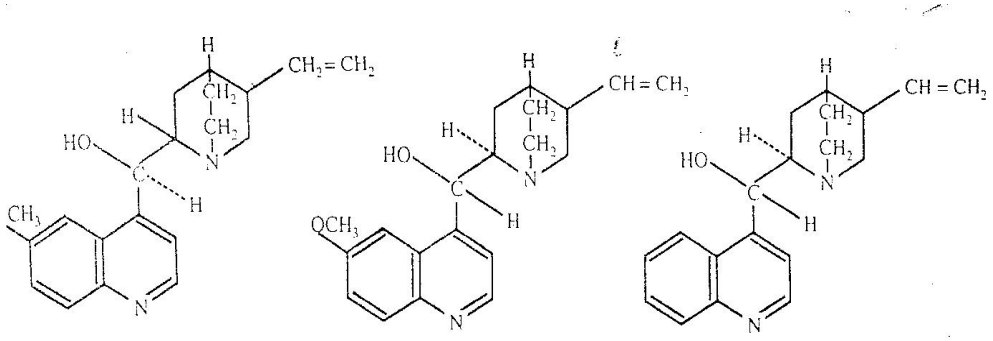


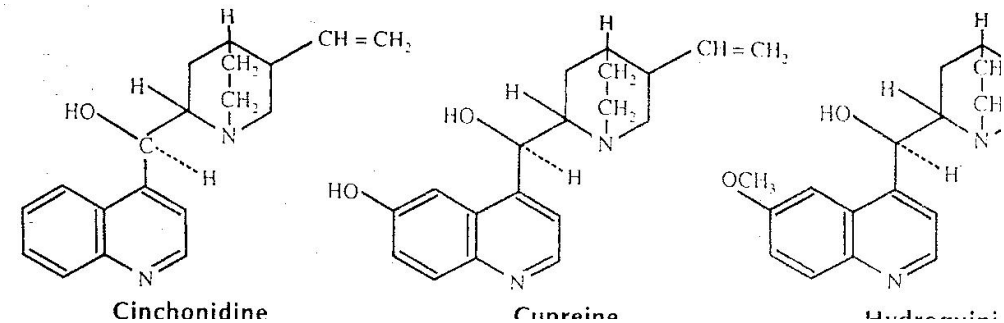
Fig. 13.29 : T.S. of Cinchona Bark

Quinines and Quinidine are steroisomers of each other. Quinidine is also obtained commercially from cuprea bark i.es, Ramijia pendunculata Fluckiger belonging to family Rubiaceae, or by isomerization of quinine.

Apart form alkaloids, cicchona also contains quinic acid and cinchotannic acid. In the plant, the alkaloids are present as salts of these acids. Cinchotannic acid decomposes into insoluble cinchona lred, due to its phlobatannin nature. Cinchona bark also contains a glycosides called quinovin, tannins and bitter essential oil.



The alkaloid quinine occurs as bitter whilte crystasls and it darkens when exposed to lilght and has fluorescent properties. It shows a strong blue fluorescence in ultra-violet light. This fluorescence is enhanced in presence of dilute sulphuric acid. Quinine forms salts with different acids. Quinine sulphate $(C_{20}H_{24}N_2O_2)_2$. H_2SO_4. $2H_2O$ is important from pharmaceutical point of view. It has very less solubility in water (1 in 810 parts of Water), duek to which, it is suitable for oral use.



Cinchonidine Cupreine Hydroquinine

Quinindine $(C_{20}H_{24}N_2O_2)_2$ is similar to quinine in its physical and chemical properties and has higher water solubility. The free base is soluble in water solubility. The free base is soluble in water, ethyl alcohol, methyl alcohol and chloroform.

Chemical Tests

(1) Heat thepowdered drug in a dried test tube with little glacial acetic acid, purple vapours are produced at the upper part of test tube.

(2) Thalleoquin test: The powdered drug gives emerald green colour with bromine water and dilute ammonia solution.

(3) Quinidine solution gives a white precipitate with silver nitrate solution, which is soluble in nitric acid.

Standards

(1) Total ash - not more than 4 per cent

(2) Foreign organic matter - nor more than 2 per cent

The UV spectrophotometric method of estimation is carried out for quinine.

Uses

Cinchona bark is antimalarial in nasture. The cinchona preparations like cinchona extract, compound cinchona tincture etc. are also employed as bitter stomachics and antipyretics. Quinine and its salts ares used in the treatment of maslasria. Quinine is protoplasmic poison, especially for protozoa llike Plasmodium vivax. P. flaciparum, P. malarie and P. fatal, and hence, used as powerfull antimalarial drug.

Recently the pharmascokinetic studies on quinine have shown that it can be better used in other forms. Infusion of quinine rather than intravenous injection eliminates the risk of sudden death. Secondly, quinine in microencapsulated form has been reported to give better bioavailability.

Quinine has also been found to be highly active in vitro against Trypanosoma cruzi epimastigotes.

Quinidine is primarily a cardiac depressant and used to prevent certain arrhythmias and tachycardia. Quinidine is valuable in prevention of atrial fibrillation.

Dose

(1) Chinchona powder – 0.3 to 1 g.

(2) Quinine sulphate - 1g daily for 2 days and then 600 mg daily for 5 days.

(3) Quinidine sulphate - 0.2 to 0.4 g every two to four hours to a total dose of 3 g dasily in atrial fibrillation.

Substitutes

Cuprea bark (Remijia pedunculata), a coppery red coloured drug, contains quinine, quinidine and other alkaloids which resemble to those frm cinchona bark. The bark contains numerous stone cells. Alongwith cinchona alkaloids, it also contains cupreine. False cuprea bark (R. purdiena) contains an alkaloid called cusconidine, traces of cinchonine, cinchonamine, but no quinine.

EPHEDRA

Synonym

Ma-Huang

Biological Source

It consists of the dried yong stems of Ephedra geradiana (wall.) Stapf, and E. nebrodensis (Tineo) Stapf, belong to family Gnetaceae (Ephedraceae). Ephedra should contain not less than 1 percent of total alkaloids, calculated as ephedrine.

Geographical source

The main source of ephedra is from China, Pakistan, North-West parts of India, Austraslia, Kenya, Spain and Yugoslavia.

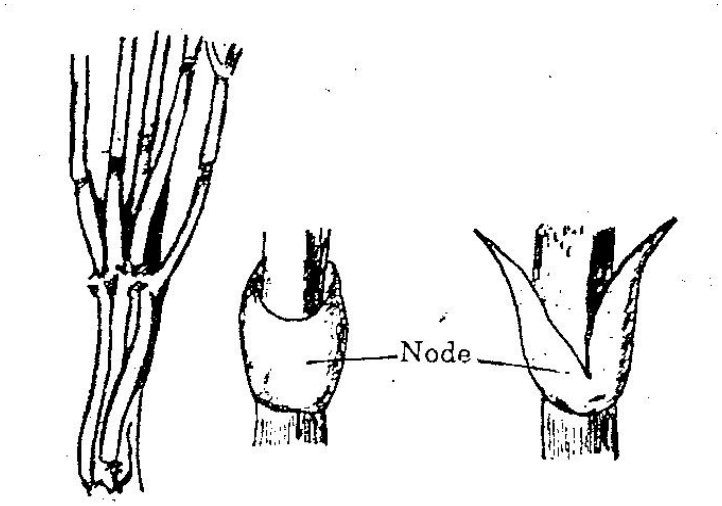
History

The drug originally belongs to Chinese System of Medicine. It has been used in China since last 5000 years. In Chinese language, it is called as Ma-Huang where ‘Ma’ denotes astrigent taste and ‘Huang’ is for yellow colour

of drug. The referenes about this drug are found in the herbal of lthe emperor Shen Nung (2700 B.C.) and in 'Chinese medicinal plants' (1596 AD.) by PenT'sao Kang Mu. In those times, it was used for treatment of respiratory problems, fever and also for improving circulation. The drug was for the first time exploredchemically by Yamanishi in Japan and he isolated ephedrine in crude form in 1885, which was further obtained in pure form by Nagai and Hari. Merek of Darmstadt, a German firm, carried out detailed search on Ephedra helvectica and isolated ephedrine in 1888. KKChen and C.F. Schmidt are mainly credited for introduction of ephedra and ephedrine in modern therapeutics

Cultivation, Collection and Preparation

Ephedra can be cultivated at an altitude of 2500 to 3000 m. Annual rainfall should not exceed 50 cm. It can be ropagated by seeds or by layers or divisions of theroot stock. Seeds are sown early in the spring at a distance of 5 cm, keeping the distance of one meter between 2 ros. The plants are collected after attaining theage of 4 years for the extraction of alkaloid. During this period, proper irrigation and weeding are necessary. The alkaloidal content of the drug varies from season to season. It is found to be maximum in autumn; when plants and twigs are dark in colour Twigs are generally dried in sun or even by artificial ways. After drying, they are stored in dry and well closed containers, away from light.



Macroscopic Characters

Ephedra is a gymnospermous plant bearing thin stems which are woody, cylindrical and grey to greenish in colour (about 5 mm in diameter). It shows the internodes at a distance of about 3 to 3.5 cm Ephedra bears the scally lleaves from the nodes in a whorl of 2. The bases of the leaves are dark brown land lthey are joined on all sides of the node-forming a sheath. It bears

a terminal bud, which is short and usually constricted at base. The male spikes are solitary, ovate, sessile and crowded.

Microscopic Characters

The T.S. of ephedra shows the following characteristics.

(i) unicellular epidermis made up of quadrangular cells along with thickwalled cuticle.

(ii) Vertical rows of sunken stomata and papillae on the ridges,

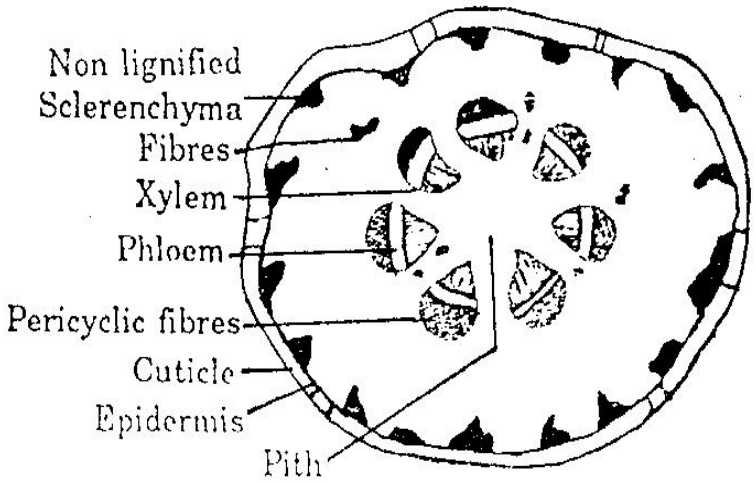
(iii) Chlorencymatous cortex,

(iv) Non lignified, hypodermal fibres,

(v) Lignified pericyclic fibres,

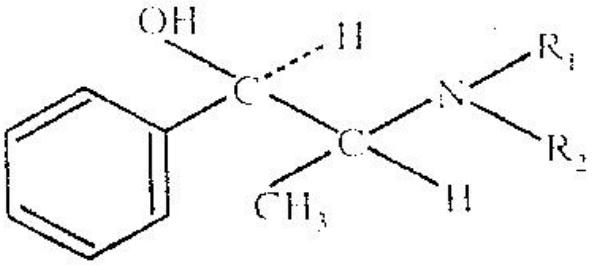
(vi) Crystals of calcium oxalate in the cortex, and

(vii) Parenchymatousdark brown coloured pith.



Chemical Constituents

Ephedra contains the amino alkaloids. They are ephedrine, nor-ehedrine, n-methylephedrine, pseudo-ehedrine etc.,



(-) Ephedrine R_1 = H R_2 = CH_3

(-) Nor-ephedrine R_1 = H, R_2 = H

(-) n-methyl ephedrine R_1 = CH_3 R_2 = CH_3

Chemically, ephedrine, ($C_{10}H_{15}$ NO) is 1-phenyl –1-hydroxy- 2-methylaminopropane and is soluble in water, alcohol, organic solvents and oils, It is odourless and colourless, deliquescent and decomposes when exposed to air.

Along with the amino alkaloids, macrocyclic alkaloids called ephedradines are present in roots. The drug also contains ozazolidone.

Chemical Test

Ephedrine is dissolved in water and dilute hydrochloric acide and then treated separately with copper sulphate and sodium hydroxide. The solution gives violet colour. If shaken with solvent ether, the organic layer shows purple and aqueous layer shows blue colour.

Uses

Ephedra and its alkaloids show sympathomirnetic effects. Hence, it is used as a bronchodilator in asthma and also in the treatment of allergic conditions like hayfever. As compared to adrenaline, the onset of action for ephedrine is slow, but the effect is much prolonged, as it is not quickly hydrolysed by mono amino oxidase in the body Ephedrine is also used to correct the low blood pressure conditions, because of its peripheral contraction of arterioles. Ephedradines have hypothensive effects.

In 1995-96 and 1996-97, India has exported total ephedrine salts of worth Rs.820.8 lakhs and Rs.1555 lakhs respectively.

COLCHICUM

Synonyms : Meadow saffron seeds, autumn crocus

Biological Source

It consists of the dired ripe seeds of Colchicum luteum Baker and Colchicum autumnale Linn., belonging to family Liliaceae. Colchicum corm is also used medicinally.

Geographical Source

It is found and cultivated in cvarious parts of Europe, like England, Czechoslovakia, Holland, Poland and Yugoslavia. It is also cultivated in India (in Western Himalaya and Kashmir regions).

History

Though, it was known froml the time of Dioscorides, it was not much used, owing to its toxic nature. In the medieaval times, Arabian peole were

using it for treatment of gout. It was reintroduced in European countries towards beginning of seventeenth century and first appeared in the London Pharmacopoeia in 1616. Pelletier and Caventou isolated colchicines in 1820.

Cultivation, Collection and Preparation

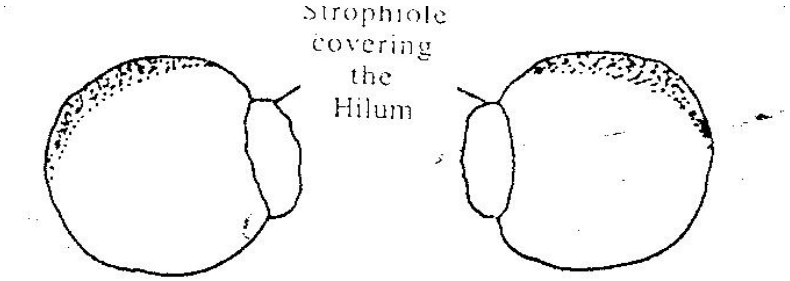
In nature, colchicum propagates by repeating the life cycle with lthe corm which is present as a swollen underground stem with sheathing leaves. Towards the End of Summer, the fully grown corm develops daughter corms in kthe axil of scaly leaf near the base. These daughter corms develop parasitically on parent corm and subsequently, thek parent corm withers away. After this, the daughter corms develop into newplants.

In Jammu and Kashmir and different parts of Europe and Africa, the drug is obtained by propagation with seeds. The propagation is done by sowing the seeds in boxes at an altitude of 1000-3000 m. The seedlings are transplanted in open fields at a distance of 1 m. The plants bear the capsular fruits after one year of vegetative growth. The fruits are collected before dehiscence and dark seeds are separated, processed and graded. The corms are isolated and the adhering scalesl and coats are removed. The corms are sliced transversely and dried below 65°C.

Macroscopic Characters

(a) Colchicum Seeds

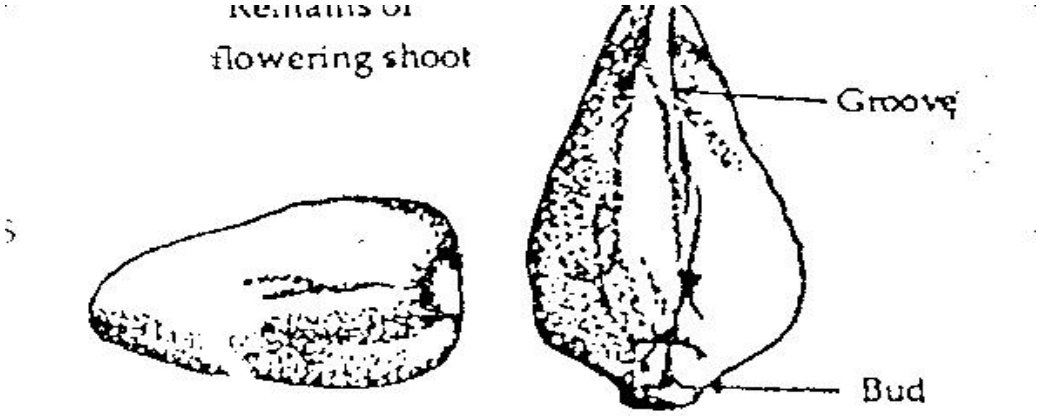
Colchicum seeds are very hard in nature and show a reddish-brown testa. The seeds have a projection at the lhilum and from there develops strophiole, which is an outgrowth of testa. The seeds are 2 – 3 mm in diameter, having bitter and acrid taste and no odour. The corms are 2 – 3 cm in diameter and used in the sliced forms which are reniform and ovate in shape, with 2- 5 mm, thickness, they have a short fracture, bitter taste and no odour.



(b) Colchicum Corms

Colour	:	Yellowish-brown
Odour	:	None
Taste	:	Bitter and acrid

Size	:	Slices are about 2 to 5 mm in thickness
Shape	:	Sub-reniform or ovate in outline or plano-convex
Extra features	:	Fracture is short and cut surfaces are White and starchy, showing grayish points.



Colchicum Corms

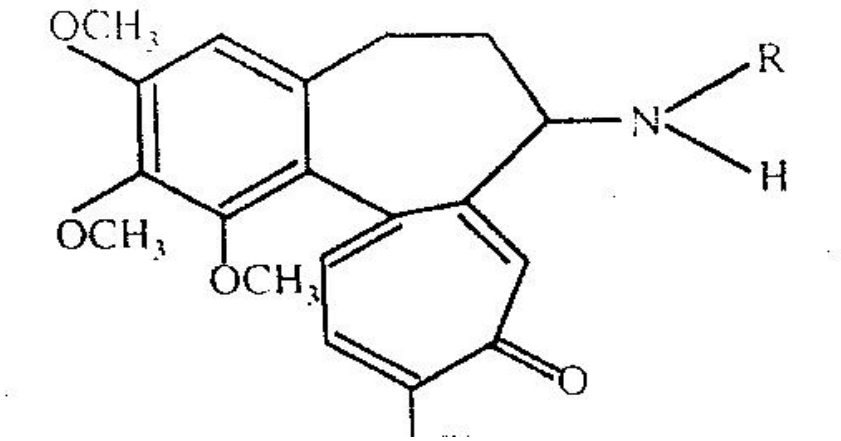
Microscopic characters

The section of seed shows parenchyma and endosperm the parenchymatous cells are reddish-brown with lthick walls. The endospermic cells shows pitted walls and contain aleurone grains and fixed oil. The strohiole portion of seed contains starch.

The corm has epidermis, parenchyma and vascular tissue. The parenchymatous cells have abundant starch grains. The epidermis hascircular stomata in vascular part, the xylem vessels are spiral or annular.

Chemical Constituents

Colchicum seed contains 02 to 1% of aminoalkaloids of lwhich colchicines is the main constituent. The seeds contain upto 0.8 per cent of colchicines and in corms, it is upto 0.6%. Colchicum also contains demecolcine. Both the alkaloids contain tropolone or cycloheptatrien-ol-one ring structure.



Colchicine, R=COCH3, Demecolcine, R = CH3

Colchicine (C22 H25O6N) is obtained as pale yellow crystal, amorphous or in powder form. It has a bitter taste and is odourless It darkens on exposure to air. Colchicine is freely soluble in alcohol and chloroform, soluble in 25 parts of water and in 220 parts of solvent ether.

Chemical Tests

(1) Colchicine gives yellow colour with 70% sulphuric acid.

(2) Alcoholic solution of colchicines, when treated with ferric chloride gives red colour.

Uses

Colchicum is a specific drug for treatment of gout and rheumatism. Colchicine also possesses antitumour activity.

Apart from medicinal use, colchicines is widely accepted and practiced as a chemical agent for brining the polyplidy (increase in number of chromosomes) and hence used in horticulturek and cultivation of medicial plants.

Dose

Colchicine : 500 – 650 μg orally 1 – 3 times a day, orally

500 μg to 1 mg, 1 – 2 times a day, intravenously

Allied Drugs

The plants having chemical contents similar to colchicines type of alkaloids belong to different genera, such as Dipidax, Cloriosa, Androcybium, Camptorrhiza, etc.,

The other genera in which colchicines is presentare from the same family Liliaceae, like Androcymbium, Bulbocodium, Dipidax,

Littonia,Fritillaria, Ornithoglossum,etc., and Narcissus and Crocus from families Amaryllidaceae and Iridaceae respectively.

VASAKA

Synonyms : Adhatoda, Adulas, Malabar nut.

Biological Source

It consists of dried, as well as, fresh leaves of the plant Adhatoda vasica Nees, Syn. Justicia adhatoda belonging to family Acanthaceae.

Geographical Source

Vasaka is indigenous to India, where it is found in sub-Himalayan track upto an altitude of 1000 m, and in Maharashtra especially, in Konkan region. Besides India, it is found in Myanmar, Sri Lanka and Malaya.

Cultivation and Collection

The uses of vasaka have been known since old times and it is included in difference formulations of ayurveda.

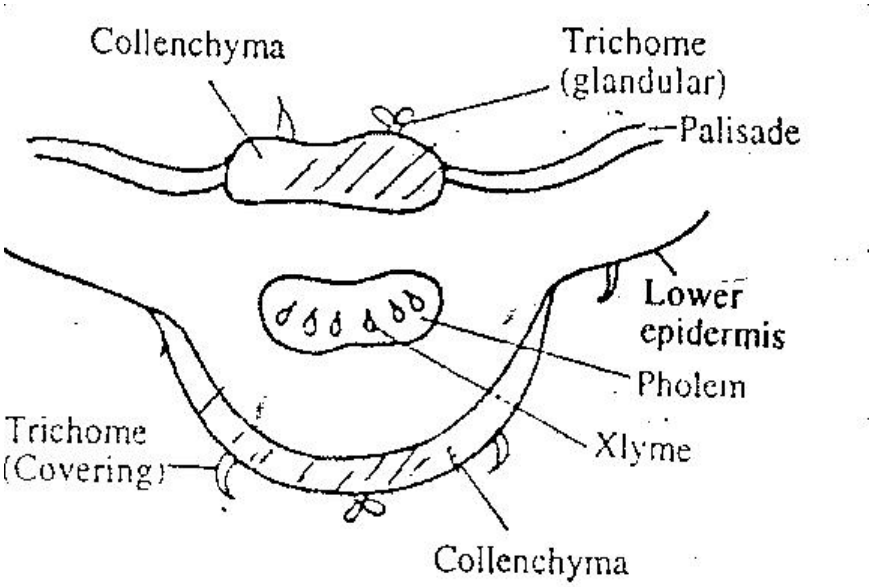
The plant is not cultivated on commercial scale. It is obtained from garden plants or wild sources. It can be easily progagated by stemk; cuttings and by seed germination. The lant is obtained in all seasons ofl the year. It reaches to a height of 2- 3 metres. It is also observed that the plant favourably grows in loamy soil.

Macroscopic Characters

The drup contains stem leaf, fruit and seeds. The leaves have 10 – 30 cm length and width of 4 – 10 cm. They are petiolate and exstipulate. The shape is lanceolate. The margin is crenate with acuminate apex. There are 8-10 pairs of lateral veins. Taste is better and odour is characteristic.

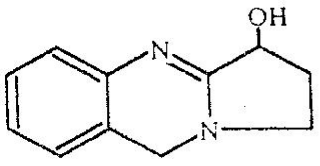
Microscopic Charaters

The epidermis shows caryophyllaceous stomata with sinous epidermal cells, and covering and glandular trichomes. It is a dorsiventral leaf with palisade having 2 layers of cells. 2 – 3 bicollateral vascular bundles are seen in midrib. Mesophyll contains prismatic and acicular crystals of calcium oxalate. Stomatal index is from 10.8 to 18.2 and palisade ratio from 5 to 8.5

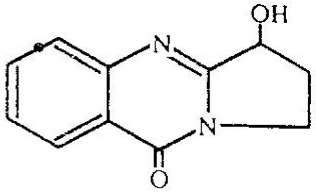


Chemical Constituents

Vasaka leaves contain quinazoline derivatives such as vasicine, vasicinone and 6-hydroxy vasicine. Biochemically, vasicine is oxidized to its ketonic derivative vasicinone and the latter exerts main activity as bronchodilator. The drug also contains volatile oil, betain and vasakin. It is also reported that vasaka contains adhatodic acid.



Vasicine



Vasicinone

Standards

Foreign organic matter – not more than 2 per cent.

Uses

Vasaka is used as expectorant and bronchodilator. The large doses are irritant and cause vommitting and diarrhoea. The pharmacological investigations have shown that vasicine also shows oxytocic property similar to oxytocin and methyl ergometrine. Vasicine also shows abortificient action and both the actions are due to relase of prostaglandins. Bromhexine HCL is a synthetic derivative of vasicine which changes the structure of bronchial secretions and reduces viscosity of sputum.

BAEL

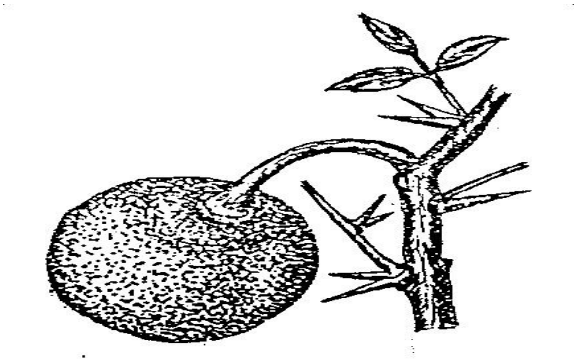
Synonyms : Bael Fruits, Bel, Indian Bael, Bengal Quince.

Biological Source

Bael consist of unripe or half ripe fruits of the plant known as Aegle marmelos Corr., family Rutaceae.

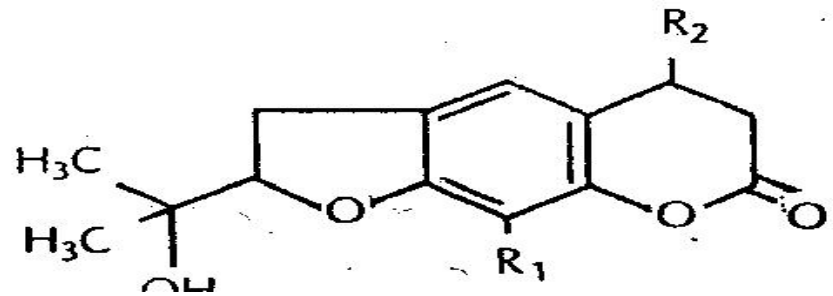
Geographical Source

It is indigenous to India and found in Myanmar and Sir Lanka.



Macroscopic Characters

The Chief constituent of lthe drug is marmelosin (0.5%), which is a furocomarin. The drug also contains carbohydrates (11 to 17%), protein, volatile oil and tannins. The pulp also contains good amount of vitamin C and vitamin A. Two alkaloids O-methylhalfordinol and isopentyi halfordinol have been isolated from fruits.



	R_1	R_2
Marmelosin A	H	H
Marmelosin B	H	CH_3
Marmelosin C	CH_3	H

Uses

It is used as digestive, appetizer and also used in the treatment of diarrhea and dysentery. It is also a tonic.

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