Semester	Course	Hours	Credit	Sub. Code	Marks		
					Internal	External	Total
III	MBE 3	6	4	18KP3BELB3	25	75	100

PHARMACOGNOSY

UNIT II:

Medicinal plants- Cultivation and propagation of medicinal plants, Methods of Collection, Harvesting, drying and storage of drugs, Preparation of crude drugs. Indian trade in medicinal and aromatic plants, conservation of medicinal plants.

UNIT III:

Quality control techniques - Adulteration and deterioration, Factors affecting herbal drugs quality. Drug evaluation – Macroscopical, Microscopical, Physicochemical, Evaluation methods.

REFERENCES

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UNIT II & III UNITS

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CULTIVATION, COLLECTION AND PROPAGATION OF MEDICINAL PLANT

The crude drugs which reach the market and pharmaceutical industries will have passed through different stages that have some effect in the nature and amount of active constituents responsible for therapeutic activity. Those stages are to be concerned more in order to make a drug useful to the mankind by all means.

Cultivation produces improved quality of plants. It helps in selecting the species, varieties or hybrids that have the desired phytoconstituents due to the controlled environmental growth better plant product is obtained and makes the collection and processing steps easier when compared to wild sources.

Cultivation results in obtaining plants with maximum secondary metabolites. It leads to industrialization in the country by the regular supply of plants. Serves as a useful tool for research purposes.

SOILS, SEEDS AND PROPAGATION MATERIAL

The physical, chemical and microbiological properties of the soil play a crucial role in the growth of plants. Water holding capacity of different sizes of soil too affects the plants. The calcium present in the soil would be very much useful for some plants where as the others does not require calcium.

The seed to be used for cultivation should be identified botanically, showing the details of its species, chemotype and origin. The seeds should be 100% traceable. The parent material should meet standard requirements regarding the purity and germination. It should be free from pests and diseases in order to guarantee healthy plant growth. Preference should be given to the resistant or tolerant species.

Plant materials or seeds derived from genetically modified organisms have to comply with national and European Union regulations. Season when the seeds should be sown and at what stage a seed should be sown should be predetermined.

Few seeds such as cinnamon losses its viability if stored for long period and the percentage of germination would be less for the seeds which were long stored.

METHODS OF PLANT PROPAGATION

Medicinal plants can be propagated by two usual methods as applicable to no medicinal plants or crops. These methods are referred as sexual method and asexual method. Each of these methods has certain advantages, and also, disadvantages.

1. Sexual method (seed propagation)

In case of sexual method, the plants are raised from seeds and such plants are known as seedlings. The sexual method of propagation enjoys following advantages:
Seedlings are long-lived (in case of perennial drugs) and bear more heavily (in case of fruits). Plants are more sturdier.Seedlings are comparatively cheaper and easy to raise

Methods of sowing the seeds

Numerous methods of sowing the seeds of the medicinal plants are in practice. Few of them using seeds for cultivationare described:

1.Broadcasting:

If the seeds are extremely small the sowingis done by broadcasting method. In this method the seeds are scattered freely in well prepared soil for cultivation. The seeds only need raking. If they are deeply sown or covered by soil, they may not get germinated. Necessary thinning of the seedlings is done by keeping a specific distance, e.g. Isabgol, Linseed, Sesame, etc.

2.Dibbling:

When the seeds of average size and weight areavailable, they are sown byplacing in holes. Number of seeds to be put in holes vary from three to five, depending upon the vitality, sex of the plants needed for the purpose and the size of the plant coming out of the seeds.

3.Miscellaneous:

Many a times the seeds are sown innursery beds. The seedlings thus produced are transplanted to farms for further growth, such as cinchona, cardamom, clove, digitalis, capsicum, etc

4.Special treatment to seeds:

To enhance germination,special treatments to seeds may be given, such as soaking the seeds in water for a day e.g. castor seeds and other slow-germinating seeds. Sometimes, seeds

are soaked in sulphuric acid e.g. henbane seeds. Alternatively, testa is partially removed by grindstone or by pounding seeds with coarse sand, e.g. Indian senna. Several plant hormones like gibberellins, auxins are also used.

2. Asexual method

In case of asexual method of vegetative propagation, the vegetative part of a plant, such as stem or root, is placed in such an environment that it develops into a new plant.

Natural methods of vegetative propagation:

Itis done by sowing various parts of the plants in well pre-pared soil. The following are the examples of vegetative propagation.

Artificial methods of vegetative propagations:

Themethod by which plantlets or seedlings are produced from vegetative part of the plant by using some technique or process is known as artificial method of vegetative propaga-tion. These methods are classified as under:

i. Cuttings

Stem cuttings
Soft wood cuttings: Berberry.
Semi hard wood cuttings: Citrus, camellia.
Hard wood cuttings: Orange, rose and bougainvi
Root cuttings: Brahmi.
Leaf cuttings: Bryophyllum.
Leaf bud cuttings.

ii. Layering

Simple layering: Guava, lemon
Serpentine layering: jasmine, clematis
Air layering (Gootee): Ficus, mango, bougainvillea, cashew nut
Mount layering
Trench layering

Tip layering

iii. Grafting

Whip grafting: Apple and rose

Tongue grafting

Side grafting: Sapota and cashew nut

Approach grafting: Guava and Sapota

Stone grafting: Mango

FACTORS AFFECTING CULTIVATION

Cultivation of medicinal plants offers wide range of advantages over the plants obtained from wild sources. There are few factors to concern which have a real effect on plant growth and development, nature and quantity of secondary metabolites. The factors affecting cultivation are altitude, temperature, rainfall, length of day, day light, soil and soil fertility, fertilizers and pests.

The effects of these factors have been studied by growing particular plants in different environmental conditions and observing variations. For example, a plant which is subjected to a particular environment may develop as a small plant which, when analyzed shows high proportion of metabolite than the plants attained the required growth. Nutrients have the ability to enhance the production of secondary metabolites, at the same time they may reduce the metabolites as well.

Altitude

Altitude is a very important factor in cultivation of medicinal plants. Tea, cinchona and eucalyptus are cultivated favourably at an altitude of 1,000–2,000 meters. Cinnamon and cardamom are grown at a height of 500–1000 metres, while senna can be cultivated at sea level. The following are the examples of medicinal and aromatic plants indicating the altitude for their successful cultivation

Temperature

Temperature is a crucial factor controlling the growth, metabolism and there by the yield of secondary metabolites of plants. Even though each species has become adapted to its own natural environment, they are able to exist in a considerable range of temperature. Many

plants will grow better in temperate regions during summer, but they lack in resistance to withstand frost in winter

Rainfall

For the proper development of plant, rainfall is required in proper measurements. Xerophytic plants like aloes do not require irrigation or rainfall. The effects of rainfall on plants must be considered in relation to the annual rainfall throughout the year with the water holding properties of the soil. Variable results have been reported for the production of constituents under different conditions of rainfall. Excessive rainfall could cause a reduction in the secondary metabolites due to leaching of water soluble substances from the plants.

Day Length and Day Light

It has been proved that even the length of the day has an effect over the metabolites production. The plants that are kept in long day conditions may contain more or less amount of constituents when compared to the plants kept in short day. For example peppermint has produced menthone, menthol and traces of menthofuran in long day conditions and only menthofuran in short day condition

Soil

Each and every plant species have its own soil and nutritive requirements. The three important basic characteristics of soils are their physical, chemical and microbiological properties. Soil provides mechanical support, water and essential foods for the development of plants. Soil consists of air, water, mineral matters and organic matters. Variations in particle size result in different soils ranging from clay, sand and gravel. Particle size influences the water holding capacity of soil. The type and amount of minerals plays a vital role in plant cultivation.

Other Factors that Affect the Cultivated Plants

Air Pollution

Chemical discharges into the atmosphere have increased dramatically during this century, but the total effect on plants is virtually unknown. It has been demonstrated that air pollutants can cause mortality and losses in growth of plants. Nearly all species of deciduous and coniferous trees are sensitive to some pollutants.

There are many chemicals released into the atmosphere singly and as compounds. In addition, other compounds are synthesized in the atmo-sphere. Some chemicals can be identified through leaf tissue analysis and by analysing the air. Generally, pollution injury first appears as leaf injury.

Spots between the veins, leaf margin discoloration, and tip burns are common. These symptoms can also be influenced by host sensitivity, which is effected by genetic characteristics and environmental factors.

Herbicide

Herbicides should be handled very carefully; misapplication of herbicides can often damage nontarget plants. The total extent of such damage remains unclear, but localized, severe damage occurs. Symptoms of herbicide injury are variable due to chemical mode of action, dosage, duration of expo-sure, plant species, and environmental conditions. Some herbicides cause growth abnormalities such as cupping or twisting of foliage while others cause foliage yellowing or browning, defoliation, or death

COLLECTION OF CRUDE DRUGS

Collection is the most important step which comes after cultivation. Drugs are collected from wild or cultivated plants and the tasks for collection depends upon the collector, whether he is a skilled or unskilled labour. Drugs should be collected when they contain maximum amount of constituents in a highly scientific manner.

The season at which each drug is collected is so important, as the amount, and sometimes the nature, of the active constituents could be changed throughout the year. For example, Rhubarb is collected only in summer seasons because no anthraquinone derivatives would be present in winter season but anthranols are converted to anthraquinones during summer.

Not only the season but also the age of the plant should be taken in to great consideration since it governs not only the total amount of active constituents produced in the plants but also the proportions of the constituents of the active mixture. High proportion of pulegone in young plants of peppermint will be replaced by menthone and mentholand reduction in the percentage of alkaloids in datura

Generally the leaves are collected just before the flowering season, e.g. vasaka, digitalis, etc., at this time it is assumed that the whole plant has come to a healthy state and

contain an optimum amount of metabolites, flowers are collected before they expand fully, e.g. clove, saffron, etc., and underground organs as the aerial parts of plant cells die, e.g. liquorice, rauwolfia, etc.

Since it is very difficult to collect the exact medicinally valuable parts, the official pharmacopoeia's has fixed certain amount of foreign matter that is permissible with drug. Some fruits are collected after their full maturity while the others are collected after the fruits are ripe. Barks are usually collected in spring season, as they are easy to separate from the wood during this season.

The barks are collected using three techniques, felling (bark is peeled off after cutting the tree at base), uprooting (the underground roots are dug out and barks are collected from branches and roots) and coppicing (plant is cut one meter above the ground level and barks are removed).

Underground parts should be collected and shaken, dusted in order to remove the adhered soil; water washing could be done if the adhered particles are too sticky with plant parts. The unorganized drugs should be collected from plants as soon as they oozes out, e.g. resins, latex, gums, etc. Discoloured drugs or drugs which were affected by insects should be rejected.

HARVESTING OF CRUDE DRUGS

Harvesting is an important operation in cultivation technology, as it reflects upon economic aspects of the crude drugs. An important point which needs attention over here is the type of drug to be harvested and the pharmacopoeial standards which it needs to achieve.

Harvesting can be done efficiently in every respect by the skilled workers. Selectivity is of advantage in that the drugs other than genuine, but similar in appearance can be rejected at the site of collection. It is, however, a laborious job and may not be economical. In certain cases, it cannot be replaced by any mechanical means, e.g. digitalis, tea, vinca and senna leaves.

The underground drugs like roots, rhizomes, tubers, etc. are harvested by mechanical devices, such as diggers or lifters. The tubers or roots are thoroughly washed in water to get rid of earthy-matter. Drugs which constitute all aerial parts are harvested by binders for economic reasons.

Many a times, flowers, seeds and small fruits are harvested by a special device known as seed stripper. The technique of beating plant with bamboos is used in case of cloves. The cochineal insects are collected from branches of cacti by brushing.

The seaweeds producing agar are harvested by long handled forks. Peppermint and spearmint are harvested by normal method with mowers, whereas fennel, coriander and caraway plants are uprooted and dried.

After drying, either they are thrashed or beaten or the fruits are separated by winnowing. Sometimes, reaping machines are also used for their harvesting.

DRYING OF CRUDE DRUGS

Before marketing a crude drug, it is necessary to process it properly, so as to preserve it for a longer time and also to acquire better pharmaceutical elegance. This processing includes several operations or treatments, depending upon the source of the crude drug (animal or plant) and its chemical nature.

Drying consists of removal of sufficient moisture content of crude drug, so as to improve its quality and make it resistant to the growth of microorganisms. Drying inhibits partially enzymatic reactions. Drying also facilitates pulverizing or grinding of a crude drug. In certain drugs, some special methods are required to be followed to attain specific standards, e.g. fermentation in case of *Cinnamomumzeylanicum*bark and gentian roots.

The slicing and cutting into smaller pieces is done to enhance drying, as in case of glycyrrhiza, squill and calumba. The flowers are dried in shade so as to retain their colour and volatile oil content. Depending upon the type of chemical constituents, a method of drying can be used for a crude drug.

Drying can be of two types –

(1) Natural (sun drying)

(2) Artificial.

1. Natural Drying (Sun-Drying)

In case of natural drying, it may be either direct sun-dryingor in the shed. If the natural colour of the drug (digitalis,clove, senna) and the volatile principles of the drug (peppermint)are to be retained, drying in shed is preferred. If the contents of the drugs are

quite stable to the temperatureand sunlight, the drugs can be dried directly in sunshine(gum acacia, seeds and fruits).

2. Artificial Drying

Drying by artificial means includes drying the drugs in (a) an oven; i.e. tray-dryers; (b) vacuum dryers and (c)spray dryers.

A)Tray dryers

The drugs which do not contain volatile oils and are quitestable to heat or which need deactivation of enzymes aredried in tray dryers. In this process, hot air of the desiredtemperature is circulated through the dryers and this facilitatesthe removal of water content of the drugs (belladonnaroots, cinchona bark, tea and raspberry leaves and gums are dried by this method).

(b) Vacuum dryers

The drugs which are sensitive to higher temperature aredried by this process, e.g. Tannic acid and digitalis leaves.

(c) Spray dryers

Few drugs which are highly sensitive to atmospheric conditions and also to temperature of vacuum-drying are dried by spray-drying method. The technique is followed for quick drying of economically important plant or animal constituents, rather than the crude drugs. Examples of spray drying are papaya latex, pectin, tannins, etc.

GARBLING (DRESSING)

The next step in preparation of crude drug for market after drying is garbling. This process is desired when sand, dirt and foreign organic parts of the same plant, not constituting drug are required to be removed. This foreign organic matter (extraneous matter) is removed by several ways and means available and practicable at the site of the preparation of the drugs.

If the extraneous matter is permitted in crude drugs, the quality of drug surfers and at times, it dose not pass pharmacopoial limits. Excessive stems in case of lobelia and stramonium need to be removed, while the stalks, in case of cloves are to be deleted.

Drugs constituting rhizomes need to be separated carefully from roots and rootlets and also stem bases. Pieces of iron must be removed with the magnet in case of castor seeds before crushing and by shifting in case of vinca and senna leaves. Pieces of bark should be removed by peeling as in gum acacia.

PACKING OF CRUDE DRUGS

The morphological and chemical nature of drug, its ultimate use and effects of climatic conditions during transportation and storage should be taken into consideration while packing the drugs. Aloe is packed in goat skin. Colophony and balsam of tolu are packed in kerosene tins, while asafoetida is stored in well closed containers to prevent loss of volatile oil.

Cod liver oil, being sensitive to sunlight, should be stored in such containers, which will not have effect of sunlight, whereas, the leaf drugs like senna, vinca and others are pressed and baled.

The drugs which are very sensitive to moisture and also costly at the same time need special attention, e.g. digitalis, ergot and squill. Squill becomes flexible; ergot becomes susceptible to the microbial growth, while digitalis looses its potency due to decomposition of glycosides, if brought in contact with excess of moisture during storage.

Hence, the chemicals which absorb excessive moisture (desiccating agents) fromthe drug are incorporated in the containers. Colophony needs to be packed in big masses to control autioxidation. Cinnamon bark, which is available in the form of quills, is packed one inside the other quill, so as to facilitate transport and to prevent volatilization of oil from the drug.

The crude drugs like roots, seeds and others do not need special attention and are packed in gunny bags, while in some cases bags are coated with polythene internally. The weight of certain drugs in lots is also kept constant e.g. Indian opium.

STORAGE OF CRUDE DRUGS

Preservation of crude drugs needs sound knowledge of their physical and chemical properties. A good quality of the drugs can be maintained, if they are preserved properly. All the drugs should be preserved in well closed and, possibly in the filled containers.

They should be stored in the premises which are water-proof, fire proof and rodentproof. A number of drugs absorb moisture during their storage and become susceptible

to the microbial growth. Some drugs absorb moisture to the extent of 25% of their weight. The moisture, not only increases the bulk of the drug, but also causes impairment in the quality of crude drug.

The excessive moisture facilitates enzymatic reactions resulting in decomposition of active constituents e.g. digitalis leaves and wild cherry bark. Gentian and ergot receive mould infestation due to excessive moisture. Radiation due to direct sun-light also causes destruction of active chemical constituents, e.g. ergot, cod liver oil and digitalis.

Form or shape of the drug also plays very important role in preserving the crude drugs. Colophony in the entire form (big masses) is preserved nicely, but if stored in powdered form, it gets oxidized or looses solubility in petroleum ether. Squill, when stored in powdered form becomes hygroscopic and forms rubbery mass on prolonged exposure to air.

The fixed oil in the powdered ergot becomes rancid on storage. In order to maintain a good quality of ergot, it is required that the drug should be defatted with lipid solvent prior to. Lard, the purified internal fat of the abdomen of the hog, is to be preserved against rancidity by adding siam benzoin. Atmospheric oxygen is also destructive to several drugs and hence, they are filled completely in well closed containers, or the air in the container is replaced by an inert gas like nitrogen; e.g. shark liver oil, papain, etc.

QUALITY MANAGEMENT

The herbal drug manufacturers should establish a quality management department which is responsible for supervision and quality control for the entire production process, and should have adequate staff, premises, instruments and equipment to meet the standard requirements of the scale of production and species identification.

The quality management department should monitor the environment and hygienic management, test production materials, packaging materials and the crude drugs, and issue testing reports, develop training plans and supervise their implementation; and also they should manage the original records of production, packaging, testing, etc.

Prior to packaging, the quality control department should test each batch of the crude drugs in accordance with the national or approved standards for crude drugs. The testing procedures should include macroscopic characters and identification, impurities, moisture, ash and acid insoluble ash, extracts, and assay for marker or active constituents. Pesticide residue, heavy metals and microbiological limits should comply with the national standards and the relevant requirements.

The testing reports should be signed by the operator and the responsible person of the quality control department, and then filed. As far as the personnel and facilities are concerned, they should possess qualifications of college education or above in pharmacy, knowledge in alternative systems of medicines, agronomy, animal husbandry or the relevant specialties, trained on production techniques, safety, and hygiene and have experience in the production crude drugs, quality management of crude drugs. Staff engaged in the field work should be familiar with cultivationtechniques, especially the use of pesticides and safety protection; those engaged in rearing should be familiar with rearing techniques.

The personnel engaged in processing, packaging or testing should undergo health examinations regularly and those suffering from infectious diseases, dermatitis or open wounds shall not be allowed to do work which is in direct contact with crude drugs

. The producer should designate a person to be responsible for checking sanitation and hygiene. The applicable range and precision of instruments, metres, measures, weighers and balances, etc. used in production and testing, should conform to the relevant requirements, their performance status should be clearly indicated, and calibration should be conducted regularly.

INDIAN TRADE IN MEDICINAL AND AROMATIC PLANTS

Recently there has been a shift in universal trend from synthetic to herbal medicine, which we can say ‘Return to Nature’. Medicinal plants have been known for millennia and are highly esteemed all over the world as a rich source of therapeutic agents for the prevention of diseases and ailments.

Nature has bestowed our country with an enormous wealth of medicinal plants; therefore, India has often been referred to as the medicinal garden of the world. Countries with ancient civilizations, such as China, India, South America, Egypt, etc., are still using several plant remedies for various conditions.

In this regard, India has a unique position in the world, where a number of recognized indigenous systems of medicine, viz. Ayurveda, Siddha, Unani, Homeopathy, Yoga and Naturopathy are being utilized for the health care of people. No doubts that the herbal drugs are popular among rural and urban community of India. The one reason for the popularity and acceptability is the belief that all natural products are safe.

The demand for plant-based medicines, health products, pharmaceuticals, food supplement, cosmetics, etc., are increasing in both developing and developed countries due to the growing recognition that the natural products are nontoxic, have less side effects and easily available at affordable prices.

Nowadays, there is a revival of interest with herbal-based medicine due to the increasing realization of the health hazards associated with the indiscriminate use of modern medicine, and the herbal drug industries is now very fast growing sector in the international market.

But unfortunately, India has not done well in this international trade of herbal industry due to lack of scientific input in herbal drugs. So, it would be appropriate to highlight the market potential of herbal products that would open floodgate for development of market potential in India.

With these objects, we reviewed here the market potential of herbalmedicine in India. The export of medicinal plants and herbs from India has been quite substantial for the last few years. India has a large endemic flora. There are more than 80,000 medicinal plants known, and nearly 180 plant-derived chemical compounds have been developed as modern pharmaceuticals, which are included in the Pharmacopoeia of India.

The domestic ayurvedic market is estimated to be US$ 1 billion, and is growing at the rate of 15–20% annually. India has been the major supplier of medicinal plants in the world market until 1977, when it was kept to second position by South Korea with export worth only Rs. 16 crore during 1978–79. The quantum of export had dropped to almost half of what it was in 1976–77 when India exported medicinal plants worth around Rs. 29.8 crore. The items of export value were opium, psyltium husks and seeds, Vincarosea, kuth roots and senna leaves and pods.

At present the annual trade of Indian medicinal plants is estimated to be 37,200 tonnes valued around US$ 93,540,272.00, which is expected to be increased to US$ 629,194,624.00 by 2005. During 1980s, India was the largest supplier of medicinal plants to the world market with the supply of 10.555 metric tonnes of medicinal plant material and about 14 metric tonnes of plant-derived products and their derivatives.

INDIAN HERBAL TRADE IN WORLD SCENARIO

The utilization of herbal drugs is on the flow, and the market is growing step by step. The annual turnover of the Indian herbal medicinal industry is about Rs. 2,300 crore as

against the pharmaceutical industry's turnover of Rs. 14,500 crore, with a growth rate of 15%.

The export of medicinal plants and herbs from India has been quite substantial in the last few years. India is the second largest producer of castor seeds in the world, producing about 125,000 tonnes per annum.

The major pharmaceuticals exported from India in the recent years are isabgol, opium alkaloids, senna derivatives, vinca extract, cinchona alkaloids, ipecac root alkaloids, solasodine, Diosgenine/16DPA, menthol, gudmar herb, mehndi leaves, papian, rauwolfia, guar gum, jasmine oil, sandalwood oil, etc.

The turnover of herbal medicines in India as over-the-counter products, ethical and classical formulations and home remedies of traditional systems of medicine is about US$ 1 billion and export of herbal crude extract is about US$ 80 million. The herbal drug market in India is about US$1 billion. Some of the medicinal plants, whose market potential is very high.

MEDICINAL PLANT-BASED INDUSTRIES IN INDIGENOUS SYSTEM OF MEDICINE

In India, it is estimated that there are about 25,000 licensed pharmacy of Indian system of medicine. Presently, about 1,000 single drugs and about 3,000 compound formulations are registered. Herbal industry in India uses about 8,000 medicinal plants. Table 7.2 contains some important manufacturer of herbal formulation.

However, none of the pharma has standardized herbal medicines using active compounds as markers linked with confirmation of bioactivity of herbal drugs in experimental animal models.

From about 8,000 drug manufactures in India, there are however not more than 25 manufactures that can be classifiedas large-scale manufactures. The annual turnover of Indian herbal industry was estimated around US$ 300 million in ayurvedic, and unani medicine was about US$ 27.7 million.

In 1998–99, it again went up to US$ 31.7 million and in 1999–2000 of the total turnover was US$ 48.9 million of ayurvedic and herbal products. Export of herbal drugs in India is around US$ 80 million. Some of the highly consumed medicinal plants are presented in the Table 7.3 with reference to their turnover.

EXPORT POTENTIAL OF INDIAN PHYTO- PHARMACEUTICAL PRODUCTS

Indian phyto-pharmaceutical products, which are in demand in the international market for their quality and potency,:

Artemisinin:

This is sesquiterpene lactone obtained from herb *Artemisia annua*, family Asteraceae, effective in treating malaria including cerebral malaria.

Berberine hydrochloride and berberinesulphate:

This is benzyl isoquinolinealkaloidal salt obtained from Berberis spp. viz. *B. aristata, B. vulgaris.* It is used astonic astringent, febrifuge, hepatic dysfunction, diabetes and in gastroenteritis.

Colchicine:

This is a yellowish benzyl tetra-hydroisoquinoline type alkaloid, obtained from many species of Colchicum (e.g. *C. luteum., C. speciosum)* and also from genera Androcymbium, Gloriosa, Iphigenia, Littonia and sandersonia. It is used to relieve gout and rheumatic problems.

Diosgenin, Hecogenin and Solasodine:

These are natural steroidal sapogenins, obtained from Dioscorea species (e.g. *D. deltoidea, D. maxicana, D. compositae andD. floribunda*); Agave spp. and Solanum spp. Respectively used in various hormonal preparations including birth control pills.

Ephedrine:

It is a protoalkaloid obtained from various spp. of Ephedra (Ma-huang) and may also be prepared by synthesis. It is used for the relief of asthma and hay fever.

CONSERVATION OF MEDICINAL PLANTS

India has one of the richest plant medical cultures in the world. Herbal plants that have been used by Ayurveda, sidda, unani&Tibetan system of health care face an uncertain future due to over exploitation. Conservation is about preventing damage and loss to our cultural heritage.

Need for conservation

a) Over one and a half million practitioners of the Indian systems of medicine, in the oral and codified streams, use medicinal plants in preventive, promotive and curative applications.

b) Medicinal plants are potential renewable natural resources

c) Several medicinal plants have been assessed as endangered, vulnerable and threatened due to over harvesting in the wild..

d) While the demand for medicinal plants is increasing their survival in their natural habitats is under growing threat.

Endangered species:

a) Endangered species those, which have already become extinct & the plants, which are on the verge of extinction.

b) IUCN has classified endangered species as:

Rare species

Species with small population restricted geographically with localised habitats. They are not in immediate danger of extinction e.g. Saracaindica

Vulnerable:

Species are under threat of or actually declining in number. e.g. Embeliaribesbeum

Endangered:

Species with low population number that are in considerable danger of becoming extinct e.g. Dioscorea.deltoida

Critically endangered:

When a species is facing an extremely high risk of extinction in wild in the immediate future e.g. Concinium

TYPES OF CONSERVATION

1. In-situ conservation
2. Ex-situ conservation

In-situ conservation

In-situ conservation is the on-site conservation or the conservation of genetic resources in natural populations of plant or animal species, such as forest genetic resources in natural populations of Teagan species This process protects the inhabitants and ensures the sustainability of the environment and ecosystem

Benefit

One benefit of *in situ* conservation is that it maintains recovering populations in the environment where they have developed their distinctive properties. Another benefit is that this strategy helps ensure the ongoing processes of evolution and adaptation within their environments.

As a last resort, ex-situ conservation may be used on some or all of the population, when *in situ* conservation is too difficult, or impossible. The species gets adjusted to the natural disasters like drought, floods, forest fires and this method is very cheap and convenient

Ex-situ conservation

Ex situ conservation literally means, "offsite conservation". It is the process of protecting an endangered species, variety or breed, of plant or animal outside its natural habitat; for example, by removing part of the population from a threatened habitat and placing it in a new location, which may be a wild area or within the care of humans.

The degree to which humans control or modify the natural dynamics of the managed population varies widely, and this may include alteration of living environments, reproductive patterns, access to resources, and protection from predation and mortality.

Ex situ management can occur within or outside a species' natural geographic range. Individuals maintained ex situ exist outside an ecological niche. This means that they are not under the same selection pressures as wild populations, and they may undergo artificial selection if maintained ex situ for multiple generations.

Benefit

The different advantages of ex-situ conservation are, It gives longer life time and breeding activity to animals. Genetic techniques can be utilized in the process. Captivity breed species can again be reintroduced in the wild.

UNIT III

DRUG ADULTERATION

Medicinal plants constitute an effective source of traditional (e.g. ayurvedic, chinese, homeopathy and unani) and modern medicine. Herbal medicine has been shown to have genuine utility. Germany and France, together represent 39% of the $14 billion global retail market.

In India, about 80% of the rural population depends on medicinal herbs and/or indigenous systems of medicine. In fact today, approximately 70% of 'synthetic' medicines are derived from plants. Popularity among the common people increased the usage of medicinal plants/herbal drugs.

Herbal adulteration is one of the common malpractices in herbal raw-material trade. Adulteration is described as intentional substitution with another plant species or intentional addition of a foreign substance to increase the weight or potency of the product or to decrease its cost. In general, adulteration is considered as an intentional practice.

However, unintentional adulterations also exist in herbal raw-material trade due to various reasons, and many of them are unknown even to the scientific com-munity. The present chapter deals with different intentional and unintentional adulterations, reasons behind them and methods for easy identification of the spurious plant and authentication of the authentic plant.

ADULTERATION

A treatise published two centuries ago (in 1820) on adulterations in food and culinary materials is a proof for this practice as an age-old one. Due to adulteration, faith in herbal drugs has declined. Adulteration in market samples is one of the greatest drawbacks in promotion of herbal products.

Many researchers have contributed in checking adulterations and authenticating them. It is invariably found that the adverse event reports are not due to the intended herb, but rather due to the presence of an unintended herb. Medicinal plant dealer have discovered the 'scientific' methods in creating adulteration of such a high quality that without microscopic and chemical analysis, it is very difficult to trace these adulterations.

Definition: The term adulteration is defined as substituting original crude drug partially or wholly with other similar-looking substances. The substance, which is mixed, is free from or inferior in chemical and therapeutic property.

Types of Adulterants

Adulteration in simple terms is debasement of an article. The motives for intentional adulteration are normally commercial and are originated mainly with the intension of enhancement of profits. Some of the reasons 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. Adulteration involves different conditions such as deterioration, admixture, sophistication, substitution, inferiority and spoilage. Deterioration is impairment in the quality of drug, whereas 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 a totally different substance is added in place of original drug. Inferiority refers to any substandard drug, and spoil-age is due to the attack of microorganisms.

Unintentional Adulteration

Unintentional adulteration may be due to the following reasons:

1. confusion in vernacular names between indigenous systems of medicine and local dialects
2. Lack of knowledge about the authentic plant
3. non availability of the authentic plant
4. similarity in morphology and or aroma
5. careless collection
6. other unknown reasons

1.Name confusion

In ayurveda, ‘Parpatta’ refers to *Fumaria parviflora*. In siddha, ‘Parpadagam’ refers to *Mollugo pentaphylla*. Owing to the similarity in the names in traditional systems of medicine, these two herbs are often interchanged or adulterated or substituted. Because of the popularity of siddha medicine in some parts of south India, traders in these regions supply *M. pentaphylla* as Parpatta/Parpadagam and the north Indiansuppliers supply *F.*

parviflora. These two can be easily identi-fied by the presence of pale yellow to mild brown-coloured, thin wiry stems and small simple leaves of *M. pentaphylla* and black to dark brown-coloured, digitate leaves with narrow segments of *F. parviflora*. *Casuarina equisetifolia* for *Tamarixindica* and *Aerva lanata* for *Bergenia ciliata* are some otherexamples of adulterations due to confusion in names.

2.Lack of knowledge about authentic source

'Nagakesar' is one of the important drugs in ayurveda. The authentic source is *Mesua ferrea*. However, market samples are adulterated with flowers of *Calophyllum inophyllum*. Though the authentic plant is available in plenty throughout the Western Ghats and parts of the Himalayas, suppliers are unaware of it. There may also be some restrictions in forest collection. Due to these reasons, *C. inophyllum* (which is in the plains) is sold as Nagakesar. Authentic flowers can be easily identified by the presence of two-celled ovary, whereas in case of spurious flowers they are single celled.

3.Similarity in morphology

Mucuna pruriens is the best example for unknown authenticplant and similarity in morphology. It is adulterated with other similar papilionaceae seeds. *M. utilis* (sold as white variety) and *M. deeringiana* (sold as bigger variety) are popular adulterants. Apart from this, *M. cochinchinensis,Canavalia virosa* and *C. ensiformis* are also sold in Indianmarkets. Authentic seeds are up to 1 cm in length with shining mosaic pattern of black and brown colour on their surface. *M. deeringiana* and *M. utilis* are bigger (1.5–2 cm) in size. *M. deeringiana* is dull black, whereas *M. utilis* is white or buff coloured

4.Lack of authentic plant

Hypericum perforatum is cultivated and sold in Europeanmarkets. In India, availability of this species is very limited. However, the abundant Indo-Nepal species *H. patulum* is sold in the name of *H. perforatum*. Market sample is a whole plant with flowers, and it is easy to identify them taxonomically. Anatomically, stem transverse section of *H.perforatum* has compressed thin phloem, hollow pith andabsence of calcium oxalate crystals. On the otherhand, *H. patulum* has broader phloem, partially hollow pith andpresence of calcium oxalate crystals.

5.Similarity in colour

It is well known that in course of time, drug materials get changed to or substituted with other plant species. ‘Ratanjot’is a recent-day example. On discussion with suppliers and nontimer forest product (NTFP) contractors, it came to be known that in the past, roots of Ventilago madraspatana were collected from Western Ghats, as the only source of ‘Ratanjot’. However, that is not the practice now.

It is clearly known that Arnebia euchroma var euchroma is the present source. Similarity in yielding a red dye, A. euchroma substitutes V. madraspatana. The description to identify these two is unnecessary because of the absence of V. madraspatana in market. Whatever is available in the market, in the name of Ratanjot, was originated from A. euchroma.

6. Careless collections

Some of the herbal adulterations are due to the carelessness of herbal collectors and suppliers. Parmelia perlata is used in ayurveda, unani and siddha. It is also used as grocery. Market samples showed it to be admixed with other species (P. perforata and P. cirrhata). Sometimes, Usnea sp. is also mixed with them. Authentic plants can be identified by their thallus nature.

7. Unknown reasons

‘Vidari’ is another example of unknown authentic plant. It is an important ayurvedic plant used extensively. Its authentic source is Pueraria tuberosa, and its substitute is Ipomoea digitata. However, market samples are not derived from these two. It is interesting to know that an endangered gymnosperm Cycas circinalis is sold in plenty as Vidari.

Intentional adulteration

Intentional adulteration may be due to the following reasons:

Substitution using inferior commercial varieties

In this type, the original drugs are substituted using infe-rior quality drugs that may be similar in morphological characters, chemical constituents or therapeutic activity. For example hog gum or hog tragacanth for tragacanth gum, mangosteen fruits for bael fruits, Arabian senna, obovate senna and Provence senna are used to adulterate senna, ginger being

adulterated with Cochin, African and Japanese ginger. *Capsicum annuum* fruits and Japanese chillies are used for fruits of *C. minimum.*

Substitution using exhausted drugs

In this type of substitution the active medicaments of the main drugs are extracted out and are used again. This could be done for the commodities that would retain its shape and appearance even after extraction, or the appearance and taste could be made to the required state by adding colouring or flavouring agents.

This technique is frequently adopted for the drugs containing volatile oils, such as: clove, fennel etc. After extraction, saffron and red rose petals are recoloured by artificial dyes. Another example is balsam of tolu that does not contain cinnamic acid. The bitterness of exhausted gentian is restored by adding aloes.

Substitution of superficially similar inferior natural substances

The substituents used may be morphologically similar but will not be having any relation to the genuine article in their constituents or therapeutic activity. Ailanthus leaves are substituted for belladona, senna, etc. saffron admixed with saff flower; peach kernels and apricot kernels for almonds;

EVALUATION OF CRUDE DRUGS

INTRODUCTION

Evaluation of a drug ensures the identity of a drug and determines the quality and purity of drugs. The main reasons behind the need for evaluation of crude drugs are biochemical variation in the drug, effect of treatment and storage of drugs, and the adulterations and substitutions. Improvements in analytical methods have definitely led to improvements in harvesting schedules, cultivation techniques, storage, activity, stability of active compounds, and product purity.

All of these gains have resulted in tremendous improvements in the quality of herbal preparations now available. ethods currently employed in evaluating herbs are organoleptic, microscopic, physical, chemical, and biological parameters.

ORGANOLEPTIC EVALUATION

Organoleptic evaluation means the study of drugs using organs of senses. It refers to the methods of analysis like colour, odour, taste, size, shape, and special features, such as: touch, texture, etc. Obviously, the initial sight of the plant or extract is so specific that it tends to identify itself.

If this is not enough, perhaps the plant or extract has a char-acteristic odour or taste. Organoleptic analysis represents the simplest, yet the most human form of analysis.Talka gum, which is used as a substitute for acacia gum could be identified by its colour and form. Talka gum is usually broken and also some tears are brown in colour and other colourless, whereas acacia is white to yellow in colour.

Mangosteen fruits are a substitute for bael fruits and can be identified by darker rind and the wedge-shaped radiate stigmas. Cuprea Bark *(Remijia pedupiculata)* differs in its morphological character with cinchona. Blood Root used as an adulterant for hydrastis is dark reddish-brown in colour, whereas hydrastis is yellow in colour. *Rheumrhaponticum* are much smaller than those of the Chineserhubarb and are easily distinguished.

MICROSCOPICAL EVALUATION

Microscopic evaluation is indispensable in the initial identification of herbs, as well as in identifying small fragments of crude or powdered herbs, and in the detection of adulterants (e.g. insects, animal faeces, mold, fungi, etc.) as well as identifying the plant by characteristic tissue features.

Every plant possesses a characteristic tissue structure, which can be demonstrated through study of tissue arrangement, cell walls, and configuration when properly mounted in stains, reagents, and media. Lignin stains red or pink with a drop of phloroglucinol and concentrated hydrochloric acid. Mucilage is stained pink with rhuthenium red, and N/50 iodine solution stains starch and hemicellulose blue.

The characteristic features of cell walls, cell contents, starch grains, calcium oxalate crystals, trichomes, fibres, vessels, etc. have been studied in details. Surinam quassia is recognized by the absence of calcium oxalate and presence of uniseriate medullary rays, crystal fibres, and wavy medullary rays of cascara bark, lignified trichomes, and plasmodesma innux vomica.

Stone cells are absent in the frangula bark, whereas they are present in cascara. Presence of pith in rhizomes and absence in roots, warty trichomes of senna, and presence or absence of crystals of aloin indicates different varieties of aloes, glandular trichomes of mint, etc.

The powder of clove stalks contains sclereids and calcium oxalate crystals, but cloves do not contain these two. *Rauwolfia micrantho, R. densiflora,* and *R. perokensis* are found to serve as an adulterant for *R. serpentine.* The roots of these species can be differentiated from *R. serpentine* byphytoconstituents are given under their respective chapters in the text, where it could be referred. Examples of identification of constituents are: copper acetate used in the detection of colophony present as an adulterant for resins, balsams, and waxes;

Holphen's test for cottonseed oil and Baudouin's test for sesame oil in olive oil; the test with acetic and nitric acids for Gurjun balsam in copaiba; Van Urk's reagent for ergot; Vitali's morins reaction for tropane alkaloids; iodine for starch; murexide test for purine bases, etc. are examples of this evaluation.Quantitative chemical tests such as acid value (resins, balsams), saponification value (balsams), ester value (balsams, volatile oils), acetyl value (volatile oils), etc. are also useful in evaluation of a drug by means of chemical treatment.Chemical assays include assays for alkaloid, resin, volatile oil, glycoside, vitamins, or other constituent.

Few examples are the assay of total alkaloid in belladonna herb, the total alkaloid and nonphenolic alkaloid in ipecacuanha, the alka-loid strychnine in nux vomica, the resin in jalap, and the vitamins in cod-liver oil.

The results obtained can conclude the presence of inferior or exhausted drug and, by proving absence of the assayed constituent, it will suggest complete substitution of a worthless article.

Instrumental analyses are used to analyse the chemi-cal groups of phytoconstituents using chromatographic and spectroscopic methods. Chromatographic methods include paper chromatography, thin-layer chromatography, gas chromatography, high-performance liquid chroma-tography, and high-performance thin-layer chromatogra-phy.

Spectroscopic methods include ultraviolet and visible spectroscopy, infrared spectroscopy, mass spectroscopy, and nuclear magnetic spectroscopy.

PHYSICAL EVALUATION

In crude plant evaluation, physical methods are often used to determine the solubility, specific gravity, optical rotation, viscosity, refractive index, melting point, water content, degree of fibre elasticity, and other physical characteristics of the herb material.

Solubility

Drugs specific behaviours towards solvents are taken into consideration. This is useful for the examination of many oils, oleoresins, etc. Few examples are the solubility of colophony in light petroleum, the solubility of balsam of Peru in solution of chloral hydrate, the solubility of castor oil in half its volume of light petroleum and the turbidity produced with two volumes of the solvent; the solubility of balsam of Peru in an equal volume of alcohol, 90%, and the production of a turbidity with a larger volume; castor oil is soluble only in three volumes of 90% alcohol, while the adulterated form it shows good solubility in alcohol. Alkaloidal bases are soluble in organic solvents and alkaloidal salts are soluble in polar solvents.

Optical Rotation

Anisotropic crystalline solids and samples containing an excess of one enantiomer of a chiral molecule can rotate the orientation of plane-polarized light. Such substances are said to be optically active, and this property is known as optical rotation. The enantiomer that rotates light to the right, or clockwise when viewing in the direction of light propagation, is called the dextrorotatory (d) or (+) enantiomer, and the enantiomer that rotates light to the left, or counterclockwise, is called the levorotatory (l) or ({) enantiomer. Few examples of drugs with this property are eucalyptus oil (0° to +10°), honey (+3° to {15°), Chenopodium oil ({30° to {80°), etc.

Refractive Index

Refractive index is defined as the property of a material that changes the speed of light, computed as the ratio of the speed of light in a vacuum to the speed of light through the material. When light travels at an angle between two different materials, their refractive indices determine the angle of transmission refraction of the light beam. In general, the refractive index varies based on the frequency of the light as well; thus, different colours of light travel at different speeds. High intensities can also change the refractive index. This

could be used as a parameter in evaluating the herbal drugs; for example castor oil 1.4758 to 1.527, clove oil 1.527 to 1.535, etc.

Specific Gravity

It is also known as relative density. The ratio of the mass of a solid or liquid to the mass of an equal volume of distilled water at 4°C (39°F) or of a gas to an equal volume of air or hydrogen under prescribed conditions of temperature and pressure. Some examples of specific gravity of drugs are cottonseed oil 0.88–0.93, coconut oil 0.925, castor oil 0.95, etc.

Viscosity

Viscosity is the resistance of a fluid to flow. This resistance acts against the motion of any solid object through the fluid and also against motion of the fluid itself past stationary obstacles. Viscosity of a liquid is constant at a given tempera-ture and is an index of its composition. Viscosity also acts internally on the fluid between slower- and faster-moving adjacent layers. Since it is constant at a given temperature, it is used as an evaluation parameter; for example, pyroxylin kinematic viscosity, 1100–2450 centistokes.

Melting Point

The melting point of a solid is the temperature at which it changes state from solid to liquid. Plant constituents have very sharp and constant melting points. As far as crude drugs are concerned, melting point range has been fixed due to mixed chemicals. The following drugs could be evaluated using this parameter; for example, beeswax 62–65°C, wool fat 34–44°C, agar melts at 85°C, etc.

Moisture Content

The moisture content of a drug will be responsible for decomposition of crude drugs either producing chemical change or microbial growth. So the moisture content of a drug should be determined and controlled. The moisture content is determined by heating a drug at 105°C in an oven to a constant weight. Following are the examples of two crude drugs with their moisture content limit: the moisture content of Digitalis and Ergot should not be more than 5% w/w and 8% w/w, respectively.

Ultraviolet Light

Certain drugs fluoresce when the cut surface or the powder is exposed to ultraviolet radiation, and it is useful in the identification of those drugs. Some pieces of rhapontic, Indian, and Chinese rhubarb are very difficult to distinguish, and it is very difficult in powdered form, but exami-nation in ultraviolet light gives such marked differences in fluorescence that the varieties can be easily distinguished from each other.

Ash Values

The determination of ash is useful for detecting low-grade products, exhausted drugs, and excess of sandy or earthy matter. Different types of ash values are used in detection of crude drugs like, total ash, acid-insoluble ash, water-soluble ash, and sulphated ash.

Total ash is useful in detecting the crude drugs that are mixed with various mineral substances like sand, soil, calcium oxalate, chalk powder, or other drugs with different inorganic contents to improve their appearance, as is done with nutmegs and ginger. The maximum temperature used for total ash should be not more than 450°C because alkali chlorides that may be volatile in higher temperatures would be lost.

Acid-insoluble ash means the ash insoluble in dilute hydrochloric acid. It is often of more value than the total ash. The majority of crude drugs contain calcium oxalate, and the quantity of calcium oxalate varies very frequently. So total ash of a crude drug vary within wide limits for specimens of genuine drug, for example, rhubarb, total ash range from 8 to 40%. In this case, the total ash is useless to detect earthy matter adherent to such a drug. So acid-insoluble ash would be preferable for rhubarb.

The calcium oxide or carbonate, yielded by the incinerated oxalate, will be soluble in hydrochloric acid when the ash is treated with hydrochloric acid; the remaining ash is weighed, which is known as the acid-insoluble ash.

By this we can detect the presence of excessive earthy matter, which is likely to occur with roots and rhizomes and with leaves which are densely pubescent, like those of foxglove, clothed with abundant trichomes secreting resin, as in henbane, and tend to retain earth matter splashed on to them during heavy rainstorms.

The water-soluble ash is used to detect the presence of material exhausted by water. Sulphated ash is done by addition of sulphuric acid in order to get sulphate salts, and the percentage ash is calculated with reference to the air-dried drug. The temperature used for

this is above 600°C. The total ash and acid-insoluble ash values of Guduchi are not more than 16 and 3%, respectively. The total ash value and water-soluble ash values of ginger are 6 and 1.7%, respectively.

Extractive Values

The extracts obtained by exhausting crude drugs with dif-ferent solvents are approximate measures of their chemical constituents. Various solvents are used according to the type of the constituents to be analysed. Water-soluble extractive is used for crude drugs containing water-soluble constitu-ents like glycosides, tannins, mucilage, etc.; alcohol-soluble extractive is used for crude drugs containing tannins, gly-cosides, resins, etc.; and ether-soluble extractives are used for drugs containing volatile constituents and fats.

Foreign Organic Matters

The parts of the organ or organs other than those parts of drugs mentioned in the definition and description of the drug are known as foreign organic matters. They may be insect, moulds, earthy material, animal excreta, etc. Each and every vegetable drug has their own limits. Few examples of such limits are: garlic should not contain more than 2%, saffron should not contain more than 2%, satavari should not contain more than 1%, etc.

Semester	Course	Hours	Credit	Sub. Code	Marks		
					Internal	External	Total
III	MBE 3	6	4	18KP3BELB3	25	75	100

PHARMACOGNOSY

UNITS III

Phytochemicals (Qualitative and Quantitative ananlysis of Secondary Metabolites- Alkaloids, Tannin, Phenols, Steriods, Terpenoids and Flavonoids) and Biological Evaluation methods.

UNIT V

Natural pesticides (*Vitex, Azardiracta*), Allergenic Plant (*Parthenium, Mucunna*), Poisonus plant *Abrus precatorius, Nerium oleander*), IPR and Patening of active Principles, Enterprenourship.

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UNIT III & V UNITS

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PHYTOCHEMICALS

Phytochemicals (from Greek phyto, meaning plant) are chemicals produced by plants through primary or secondary metabolism. They generally have biological activity in the plant host and play a role in plant growth or defense against competitors, pathogens, or predators.

Phytochemicals generally are regarded as research compounds rather than essential nutrients because proof of their possible health effects has not been established yet. Phytochemicals under research can be classified into major categories, such as carotenoids and polyphenols, which include phenolic acids, flavonoids, and stilbenes lignans. Flavonoids can be further divided into groups based on their similar chemical structure, such as anthocyanins, flavones, flavanones, and isoflavones, and flavanols. Flavanols further are classified as catechins, epicatechins, and proanthocyanidins. In total, there has been over 25,000 phytochemicals discovered and in most cases, these phytochemicals are concentrated in colourful parts of the plants like fruits, vegetables, nuts, legumes, and whole grains, etc.

Phytochemists study phytochemicals by first extracting and isolating compounds from the origin plant, followed by defining their structure or testing in laboratory model systems, such as cell cultures, in vitro experiments, or in vivo studies using laboratory animals. Challenges in that field include isolating specific compounds and determining their structures, which are often complex, and identifying what specific phytochemical is primarily responsible for any given biological activity.

QUALITATIVE AND QUANTITATIVE ANANLYSIS OF SECONDARY METABOLITES

Qualitative ananlysis

Qualitative analysis uses subjective judgment to analyze a company's value or prospects based on non-quantifiable information, such as management expertise, industry cycles, strength of research and development, and labor relations.

Quantitative analysis

Quantitative analysis (QA) is a technique that uses mathematical and statistical modeling, measurement, and research to understand behavior. Quantitative analysts represent a given reality in terms of a numerical value.

Secondary metabolites

Secondary metabolites are compounds that are not required for the growth or reproduction of an organism but are produced to confer a selective advantage to the organism. For example, they may inhibit the growth of organisms with which they compete and, as such, they often inhibit biologically important processes.

Alkaloids

Alkaloids are a class of basic, naturally occurring organic compounds that contain at least one nitrogen atom. This group also includes some related compounds with neutral and even weakly acidic properties. Some synthetic compounds of similar structure may also be termed alkaloids. In addition to carbon, hydrogen and nitrogen, alkaloids may also contain oxygen, sulfur and, more rarely, other elements such as chlorine, bromine, and phosphorus.

Alkaloids are produced by a large variety of organisms including bacteria, fungi, plants, and animals. They can be purified from crude extracts of these organisms by acid-base extraction, or solvent extractions followed by silica-gel column chromatography. Alkaloids have a wide range of pharmacological activities including antimalarial (*e.g.* quinine), antiasthma (*e.g.* ephedrine), anticancer (*e.g.* homoharringtonine), cholinomimetic (*e.g.* galantamine), vasodilatory (*e.g.* vincamine), antiarrhythmic (*e.g.* quinidine), analgesic (*e.g.* morphine), antibacterial (*e.g.* chelerythrine), and antihyperglycemic activities (*e.g.* piperine). Many have found use in traditional or modern medicine, or as starting points for drug discovery. Other alkaloids possess psychotropic (*e.g.* psilocin) and stimulant activities (*e.g.* cocaine, caffeine, nicotine, theobromine), and have been used in entheogenic rituals or as recreational drugs. Alkaloids can be toxic too (*e.g.* atropine, tubocurarine). Although alkaloids act on a diversity of metabolic systems in humans and other animals, they almost uniformly evoke a bitter taste.

The boundary between alkaloids and other nitrogen-containing natural compounds is not clear-cut. Compounds like amino acid peptides, proteins, nucleotides, nucleic acid, amines, and antibiotics are usually not called alkaloids. Natural compounds containing nitrogen in the exocyclic position (mescaline, serotonin, dopamine, etc.) are usually classified as amines rather than as alkaloids. Some authors, however, consider alkaloids a special case of amines

Tannin

Tannins (tannoids) are a class of astringent, polyphenolic biomolecules that bind to and precipitate proteins and various other organic compounds including amino acids and alkaloids.

The term *tannin* (from Anglo-Norman *tanner*, from Medieval Latin *tannāre*, from *tannum*, oak bark) refers to the use of oak and other bark in tanning animal hides into leather. By extension, the term *tannin* is widely applied to any large polyphenolic compound containing sufficient hydroxyls and other suitable groups (such as carboxyls) to form strong complexes with various macromolecules.

The tannin compounds are widely distributed in many species of plants, where they play a role in protection from predation (including as pesticides) and might help in regulating plant growth. The astringency from the tannins is what causes the dry and puckery feeling in the mouth following the consumption of unripened fruit, red wine or tea. Likewise, the destruction or modification of tannins with time plays an important role when determining harvesting

times.Tannins have molecular weights ranging from 500 to over 3,000 (gallic acid esters) and up to 20,000

Phenols

In organic chemistry, phenols, sometimes called phenolics, are a class of chemical compounds consisting of one or more hydroxyl groups (-OH) bonded directly to an aromatic hydrocarbon group. The simplest is phenol, C_6H_5OH. Phenolic compounds are classified as simple phenols or polyphenols based on the number of phenol units in the molecule. Phenols are both synthesized industrially and produced by plants and microorganisms

Steroids

Steroids are a man-made version of chemicals, known as hormones, that are made naturally in the human body. Steroids are designed to act like these hormones to reduce inflammation. They're also known as corticosteroids, and are different to anabolic steroids used by bodybuilders and athletes.

Terpenoids

The terpenoids, sometimes called isoprenoids, are a large and diverse class of naturally occurring organic chemicals derived from the 5-carbon compound isoprene, and the isoprene polymers called terpenes. Most are multicyclic structures with oxygen-containing functional groups. About 60% of known natural products are terpenoids. Although sometimes used interchangeably with terpenes, terpenoids contain additional functional groups, usually O-containing. Terpenes are hydrocarbons.

Plant terpenoids are used for their aromatic qualities and play a role in traditional herbal remedies. Terpenoids contribute to the scent of eucalyptus, the flavors of cinnamon, cloves, and ginger, the yellow color in sunflowers, and the red color in tomatoes. Well-known terpenoids include citral, menthol, camphor, salvinorin A in the plant *Salvia divinorum*, the cannabinoids found in cannabis, ginkgolide and bilobalide found in *Ginkgo biloba*, and the curcuminoids found in turmeric and mustard seed. The provitamin beta carotene is a terpene derivative called a carotenoid.

The steroids and sterols in animals are biologically produced from terpenoid precursors. Sometimes terpenoids are added to proteins, e.g., to enhance their attachment to the cell membrane; this is known as isoprenylation.

Flavanoids

Flavonoids (bio flavonoids from the Latin word *flavus*, meaning yellow, their color in nature) are a class of polyphenolic secondary metabolites found in plants, and thus commonly consumed in diets. Chemically, flavonoids have the general structure of a 15-carbon skeleton, which consists of two phenyl rings (A and B) and a heterocyclic ring (C). This carbon structure can be

abbreviated C6-C3-C6. According to the IUPAC nomenclature, they can be classified into:

- Flavonoids or bioflavonoids
- Isoflavonoids, derived from 3-phenylchromen-4-one (3-phenyl-1,4-benzopyrone) structure
- Neoflavonoids, derived from 4-phenylcoumarine (4-phenyl-1,2-benzopyrone) structure

The three flavonoid classes above are all ketone-containing compounds and as such, anthoxanthins (flavones and flavonols). This class was the first to be termed bioflavonoids. The terms flavonoid and bioflavonoid have also been more loosely used to describe non-ketone polyhydroxy polyphenol compounds, which are more specifically termed flavanoids. The three cycles or heterocycles in the flavonoid backbone are generally called ring A, B, and C. Ring A usually shows a phloroglucinol substitution pattern.

BIOLOGICAL EVALUATION METHODS

Following method

Methodology is a contextual framework' for research, a coherent and logical scheme based on views, beliefs, and values, that guides the choices researchers make. It comprises the theoretical analysis of the body of methods and principles associated with a branch of knowledge such that the methodologies employed from differing disciplines vary depending on their historical development. This creates a continuum of methodologies that stretch across competing understandings of how knowledge and reality are best understood. This situates methodologies within overarching philosophies and approaches.

Methodology may be visualized as a spectrum from a predominantly quantitative approach towards a predominantly qualitative approach. Although a methodology may conventionally sit specifically within one of these approaches, researchers may blend approaches in answering their research objectives and so have methodologies that are multimethod and interdisciplinary.

Overall, a methodology does not set out to provide solutions - it is therefore, not the same as a method. Instead, a methodology offers a theoretical perspective for understanding which method, set of methods or best practices can be applied to the research question(s) at hand.

Paw edema method:

Paw swelling, or footpad edema, is a con- venient method for assessing inflammatory responses to antigenic challenges and irritants (Winter *et al.,* 1962; Otterness and Moore, 1988). The model described in this unit uses carrageenan as the irritant to induce paw edema.

Cotton wool granuloma method:

The cotton pellet granuloma method has been widely used to assess the transudative, exudative and a proliferative phase of subacute inflammation. The fluid adsorbed by the pellet greatly influences the wet weight of the granuloma, whereas the dry weight correlate well with the

amount of granulomatous tissue formed.

Antipyretic activity of drug:

An antipyretic is a substance that reduces fever. Antipyretics cause the hypothalamus to override a prostaglandin-induced increase in temperature. The body then works to lower the temperature, which results in a reduction in fever.

Streptozotocin induced diabetes:

Diabetes is induced by streptozotocin (STZ), a glucosamine–nitrosourea compound derived from Streptomyces achromogenes that is used clinically as a chemotherapeutic agent in the treatment of pancreatic β cell carcinoma. STZ damages pancreatic β cells, resulting in hypoinsulinemia and hyperglycemia.

Hot Plate Method:

The hot plate test is a test of the pain response in animals, similar to the tail flick test. Both hot plate and tail-flick methods are used generally for centrally acting analgesic, while peripherally acting drugs are ineffective in these tests but sensitive to acetic acid-induced writhing test. The hot plate test is used in basic pain research and in testing the effectiveness of analgesics by observing the reaction to pain caused by heat. It was proposed by Eddy and Leimbach in 1953. They used a behavioral model of nociception where behaviors such as jumping and hind paw-licking are elicited following a noxious thermal stimulus. Licking is a rapid response to painful thermal stimuli that is a direct indicator of nociceptive threshold. Jumping represents a more elaborated response, with a latency, and encompasses an emotional component of escaping

Tail immersion test:

The tail flick test is a test of the pain response in animals, similar to the hot plate test. It is used in basic pain research and to measure the effectiveness of analgesics, by observing the reaction to heat. It was first described by D'Amour and Smith in 1941

Heffner's tail clip method

Haffner's Tail Clip Method. A metal artery clip was applied to root of the mice tail to induce pain. A sensitivity test was carried out and animals that were not attempted to dislodge the clip within 10 sec were discarded. The responsive mice were allotted to groups of six animals each.

UNIT -V

NATURAL PESTICIDS

Pesticides are substances that are meant to control pests. The term pesticide includes all of the following: herbicide, insecticides (which may include insect growth regulators, termiticides, etc.) nematicide, molluscicide, piscicide, avicide, rodenticide, bactericide, insect repellent, animal repellent, antimicrobial, and fungicide. The most common of these are herbicides which account for approximately 80% of all pesticide use. Most pesticides are intended to serve as plant protection products (also known as crop protection products), which in general, protect plants from weeds, fungi, or insects.

Neem has long been used for its medicinal and culinary properties.

Nearly all parts of the neem tree are useful, and many of its medicinal and cosmetic uses are based on its antibacterial and antifungal properties. Neem is commonly used in shampoos for treating dandruff and in soaps or creams for skin conditions such as acne, psoriasis, and athlete's foot.

Onion and Garlic Spray.

A garlic and onion spray, for example, is one of the most versatile pesticides for use both indoors and out, on edibles and ornamentals. Chop four cloves of garlic and a large onion, put into a kitchen blender and add two teaspoons of red pepper (cayenne or chili) or two finely chopped fresh hot peppers.

Eucalyptus Oil.

Research suggests that eucalyptus oil eases joint pain. In fact, many popular over-the-counter creams and ointments used to soothe pain from conditions like osteoarthritis and rheumatoid arthritis contain this essential oil. Eucalyptus oil helps to reduce pain and inflammation associated with many conditions.

Chrysanthemum Flower Tea.

This is great news because chrysanthemum is fairly safe to drink a little everyday and it tastes delicious. Chrysanthemum tea can be combined with honey, green tea, most black teas, and goji berries. Please be advised that this is not medical advice.

Vitex

Vitex agnus-castus is the most common *vitex* used medicinally. The *Vitex agnus-castus* fruit, also known as chasteberry or monk's pepper, is about the size of a peppercorn. It's produced by the chaste tree, which acquired its name because its fruit was likely used to decrease men's libido during the Middle Ages

Azardiracta

Azadirachta indica, commonly known as neem, nimtree or Indian lilac, is a tree in the mahogany family Meliaceae. It is one of two species in the genus *Azadirachta*, and is native to the

Indian subcontinent. It is typically grown in tropical and semi-tropical regions. Neem trees also grow in islands located in the southern part of Iran. Its fruits and seeds are the source of neem oil

ALLERGENIC PLANT

A few allergenic grasses include orchard grass, bluegrass, timothy, Johnson grass, Bermuda grass, and redtop. “Late-summer and fall allergenic plants include many weeds such as ragweed, pigweed, lambs quarters, and wormwood, Ferree explained. Common and giant ragweeds are serious hazards to hay fever sufferers.

Parthenium

Parthenium is a genus of North American shrubs in the sunflower tribe within the daisy family. The name *Parthenium* is an evolution of the Greek name for the plant, (*parthenion)*. The name is possibly derived from the Greek word (*parthenos*) which means virgin. Parthenium or Gajar Ghans is the most common invasive species in India. *Parthenium hysterophorus* plant causes milk disease in livestock and also responsible for respiratory malfunction in humans.

Members of the genus are commonly known as feverfew. Notable species include guayule (*P. argentatum*) which has been used as a rubber substitute, especially during the Second World War and also *P. hysterophorus*, a serious invasive species in the Old World

Mucunna

Mucuna pruriens is a tropical legume native to Africa and tropical Asia and widely naturalized and cultivated. Its English common names include monkey tamarind, velvet bean, Bengal velvet bean, Florida velvet bean, Mauritius velvet bean, Yokohama velvet bean, cowage, cowitch, lacuna bean, and Lyon bean. The plant is notorious for the extreme itchiness it produces on contact, particularly with the young foliage and the seed pods. It has agricultural and horticultural value and is used in herbalism.

POISONS PLANT

Abrus precatorius

Abrus precatorius, commonly known as jequirity bean or rosary pea, is a herbaceous flowering plant in the bean family Fabaceae. It is a slender, perennial climber with long, pinnate-leafleted leaves that twines around trees, shrubs, and hedges.

The plant is best known for its seeds, which are used as beads and in percussion instruments, and which are toxic because of the presence of abrin. Ingestion of a single seed, well chewed, can be fatal to both adults and children. The plant is native to Asia and Australia. It has a tendency to become weedy and invasive where it has been introduced.

Nerium oleander

Nerium oleander most commonly known as nerium or oleander, is a shrub or small tree in the dogbane family Apocynaceae, cultivated worldwide in temperate and subtropical areas as an

ornamental and landscaping plant. It is the only species currently classified in the genus *Nerium*. It is so widely cultivated that no precise region of origin has been identified, though it is usually associated with the Mediterranean Basin. *Nerium* grows to 2–6 m (7–20 ft) tall. It is most commonly grown in its natural shrub form, but can be trained into a small tree with a single trunk. It is tolerant to both drought and inundation, but not to prolonged frost. White, pink or red five-lobed flowers grow in clusters year-round, peaking during the summer. The fruit is a long narrow pair of follicles, which splits open at maturity to release numerous downy seeds.

Several compounds in *Nerium* exhibit toxicity, and it has historically been considered a poisonous plant. However, its bitterness renders it unpalatable to humans and most animals, so poisoning cases are rare and the general risk for human mortality is low. Ingestion of larger amounts may cause nausea, vomiting, excess salivation, abdominal pain, bloody diarrhea and irregular heart rhythm. Prolonged contact with sap may cause skin irritation, eye inflamation and dermatitis.

IPR

Intellectual property (IP) is a category of property that includes intangible creations of the human intellect. There are many types of intellectual property, and some countries recognize more than others. The most well-known types are copyrights, patents, trademarks and trade secrets. Early precursors to some types of intellectual property existed in societies such as ancient rome but the modern concept of intellectual property developed in England in the 17th and 18th centuries. The term "intellectual property" began to be used in the 19th century, though it was not until the late 20th century that intellectual property became commonplace in the majority of the world's legal systems.

The main purpose of intellectual property law is to encourage the creation of a wide variety of intellectual goods. To achieve this, the law gives people and businesses property rights to the information and intellectual goods they create, usually for a limited period of time. This gives economic incentive for their creation, because it allows people to profit from the information and intellectual goods they create. These economic incentives are expected to stimulate innovation and contribute to the technological progress of countries, which depends on the extent of protection granted to innovators. The intangible nature of intellectual property presents difficulties when compared with traditional property like land or goods. Unlike traditional property, intellectual property is "indivisible", since an unlimited number of people can "consume" an intellectual good without it being depleted. Additionally, investments in intellectual goods suffer from problems of appropriation: a landowner can surround their land with a robust fence and hire armed guards to protect it, but a producer of information or literature can usually do very little to stop their first buyer from replicating it and selling it at a lower price. Balancing

rights so that they are strong enough to encourage the creation of intellectual goods but not so strong that they prevent the goods' wide use is the primary focus of modern intellectual property law.

Patenting of active Principles

Patents on active ingredients are referred to as primary patents. In later phases of the drug development, patents are filed on other aspects of active ingredients such as different dosage forms, formulations, production methods etc. These patents are referred to as secondary patents. The term “active principle” refers to the intrinsic chemical substance which induces pharmacological activity. The active principles are mainly formed during the period of plant growth when metabolic transformation is at its greatest.

Enterprenourship

Entrepreneurship is the creation or extraction of value. With this definition, entrepreneurship is viewed as change, which may include other values than simply economic ones. More narrow definitions have described entrepreneurship as the process of designing, launching and running a new business, which is often initially a small business, or as the "capacity and willingness to develop, organize and manage a business venture along with any of its risks to make a profit. The people who create these businesses are often referred to as entrepreneurs. While definitions of entrepreneurship typically focus on the launching and running of businesses, due to the high risks involved in launching a start-up, a significant proportion of start-up businesses have to close due to lack of funding, bad business decisions, government policies, an economic crisis, lack of market demand, or a combination of all of these.

A somewhat broader definition of the term is sometimes used, especially in the field of economics. In this usage, an entrepreneur is an entity which has the ability to find and act upon opportunities to translate inventions or technologies into products and services: The entrepreneur is able to recognize the commercial potential of the invention and organize the capital, talent, and other resources that turn an invention into a commercially viable innovation. In this sense, the term entrepreneurship also captures innovative activities on the part of established firms, in addition to similar activities on the part of new businesses. Yet, the definition is still narrow in the sense that it still focuses on the creation of economic (commercial) value.