Unit 1

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1.1 Herbs as Raw Materials

1.1.1 Definition

- ***Herbs***: are crude plant materials which may be entire, fragmented or powdered. Herbs include, Example- the entire aerial part, leaves, flowers, fruits, seeds, roots, bark (stems) of trees, tubers, rhizomes or other plant parts.
- ***Herbal medicines***: Herbal medicines include herbs and/or herbal materials and/or herbal preparations and/or finished herbal products in a form suitable for administration to patients
- ***Medicinal herbal products***: finished, labelled pharmaceutical products in dosage forms that contain one or more of the following: powdered plant materials, extracts, purified extracts, or partially purified active substances isolated from plant materials. Medicines containing plant material combined with chemically defined active substances, including chemically defined, isolated constituents of plants, are not considered to be herbal medicines.
- ***Herbal preparations***: are produced from herbal materials by physical or biological processes.

  These processes may be extraction (with water, alcohol, supercritical carbon dioxide (CO2)), fractionation, purification, concentration, fermentation and other processes. They also include processing herbal materials with a natural vehicle or steeping or heating them in alcoholic beverages and/or honey, or in other materials.

  The resulting herbal preparations include, among others, simply comminuted (fragmented) or powdered herbal materials as well as extracts, tinctures, fatty (fixed) or essential oils, expressed plant juices, decoctions, cold and hot infusions.

1.1.2 Selection, Identification and Authentication of Herbal Materials

Authenticated raw material is the basic starting point in developing a botanical product. Conscious efforts must therefore be made to ensure that the botanical identity of test materials is rigorously confirmed and documented through preservation of vouchers, and that their geographic origin and handling are appropriate. Use of material with an associated herbarium voucher that can be botanically identified is always ideal. Indirect methods of authenticating bulk material in commerce, for example use of organoleptic, anatomical, chemical, or molecular characteristics, are not always acceptable for the chemist's purposes. Familiarity with botanical and pharmacognostic literature is necessary to determine what potential adulterants exist and how they may be distinguished.

1.1.3 Processing of Herbal Raw Materials

Introduction

Before using a crude drug for production of herbal formulations, it should be properly processed so that, the active constituents and the appearance of the drug do not deteriorate. The information on the raw material(s) and the solvents/reagents or vehicles used for the Herbal Stock(s) and final dilution preparation should be evaluated. For raw materials of botanical origin, the scientific name -genus, species, variety, chemo type, parts employed and other names

should be provided. For raw materials of biological origin, the scientific name (Example-, animal), -genus, species- tissue(s), fluid(s), parts of organ(s) or organ(s) used and other names should be evaluated. For minerals or chemicals, the international non-proprietary name (I.N.N), chemical and other names should be evaluated. For raw materials of botanical origin, the state (Example- fresh, dried) of the material used and, where applicable, information on pharma-cological active, toxic constituents or marker compound(s), if applicable, should be analyzed. Additionally a macroscopic and microscopic descri-ption of the raw material should be evaluated. For raw materials of biological origin, information on the physical and/or anatomical and histological state (where applicable) should be evaluated. For minerals or chemicals, physical form, structural formula, molecular formula and relative molecular mass, where applicable, should be evaluated. The preparation of a crude drug for the market depends on the following major processes.

Collection

Collection of drugs from cultivated plants always ensures a true natural source and reliable products. This may or may not be this case when drugs are cultivated from wild plants.

Following are factors to be considered at the time of collection	
Labour	Drugs may be collected from wild or cultivated plants and the task may be undertaken by casual, unskilled native labour. Example- Ipecacuanha
	Drug may be collected by skill worker in a highly scientific manner. Example- Digitalis, Cinchona, Belladona
Season	The season at which each drug is collected is also important, since the amount and sometimes the nature of the active constituents is not constructed through the year. Example- Podophyllum, Ephedra, Rhubarb, Aconite
	Rhubarb contains no anthraquinone derivatives in winter but contain anthranols which on the arrival of warmer weather are converted by oxidation into anthraquinone.
Age	The age of plant is also considerable important and governs not only the total quntity of active constitute produced but also the components of the active mixure. Clove (volatile oil): Cloves contain about 11-21% oil while mother blown cloves contain very little oil. Datura (alkaloids): The hyoscine/hyoscyamine ratio falls from about 80% in young seedlings to about 30% in mature frutings plants.
Geographical location	Geographical location also affects the cultivation in a certain extent. Location helps in development of the desired type and amount of constitutes. Example- *Ammi vianaga* growing wild in the mediteranean area contains variety of a coumarins and chromones in its seeds, however same plant cultivated in Arizona, found to produce plenty seeds practilly devoid of the desired constituents

Harvesting

Harvesting is the process of collection of the highest quality crude drug from its original source in the appropriate season and time of the day.

- Leaves are collected from plants during the flowering season when the plant is very active.
- Bark is collected in spring or early summer.

- Flowers are collected about the time of pollination in dry weather in the forenoon when the dew has disappeared and dried in shade.
- Roots and tubers are collected in autumn when the plant is inactive and the vegetative process has ceased and contain the maximum active constituents.

Drying

Drying is essential for maintaining the quality of crude drugs after collection to avoid decomposition, microbial growth, enzyme activation and other possible chemical changes. Herbal raw drugs are dried prior to extraction to avoid detoriation on storage and transport as well as to facilitate grinding. In the preparation of crude drugs, drying is usually designed to yield a stable, homogenous product which is easy to manupulate in subsequent operation of storage and packaging.

Drying is defined as the removal of a liquid or moisture contents from a material (herbal drugs) by the application of heat and is accomplished by the transfer of a liquid or moisture content from a surface into an unsaturated vapour phase.

Proper and successful drying depends on control of temperature and regulation of air flow. Drying process is to be done depending upon source of herbal crude drug and its chemical nature.

- If enzymatic action is to be encouraged, slow drying is necessary at moderate temperature. Example- Orris rhizome, Vanilla pods, Cocoa seed, Gentian root.
- If enzymatic action is not desired, drying should take place as soon as possible after collection. Drugs containing volatile oil are liable to lose their aroma if not dried or if the oil is not distilled from them immediately.

Two types of drying are classified as follows:

1. **Natural drying (sun drying)**
   - **(a)** ***Direct sun drying (outdoor drying)***: The crude drugs can be dried directly in sunshine if the contents of crude drugs are quite stable to the temperature and sunlight. Example: Gum acacia, seeds, fruit are dried by direct sun drying method.
   - **(b)** ***Shed drying:*** Shed drying is prepared when the natural colors of the drug (digitalis leaves, clove, senna leaves) and volatile principles of the drug (Example- Peppermint) are to be retained. Drying in the shed at the air temperature is frequently adopted especially for leaves containing oil.
2. **Artificial drying**
   - **(a)** ***Tray dryer: (truck dryer):*** This is most commonly used method in the pharmaceutical plant operatation. Tray dryers are used for drying heat stable plant material. Example- roots, barks. In this process, hot air of desired temperature is circulated through the dryers and this facilitates the removal of water content of the drugs. This is simplest and inexpensive method. Disadvantage of tray dryers is deterioration of material due to high residence time at high temperature.

(b) ***Vaccum dryer:*** In this method, vaccum facilitates drying of plant material at low temperature. It can handle stiky, free flowing, hygroscopic, heat sensitive plant materials. Examples- Tannic acid, Digitalis leaves.

(c) ***Spray dryer:*** This is used for non-hygroscopic products. This is continous, thermally efficient dryer where filtered atmospheric hot air comes in contact with atomized fine mist of the feed and instantly evaporates the water in the feed droplets. The fluidized mixture of air and powder get separted in cyclone separator. This method of drying retains all the original properties of plant material such as color, aroma, efficacy, density etc.

Pulverisation

Pulverisation or comminution is a process of fragmenting a substance into small particles by mechanical forces. It is one of the important process operation and inevitable in very first step of herbal extraction. Comminution of different parts of the herbal drugs can be explained as followed.

Crude Drug	Details and type of mills useful
Leaf drugs	Leaf drugs are predominant in herbal industry. • Shredding mills - medicinal leaves and herbs with high content of stem and stalk • Hammer mills- for resinous and friable leaf drugs • Pin mills – leaf drugs with high fat content or ethereal oil.
Roots and barks	Roots and barks are moderately hard or woody but sometimes brittle and friable also. Example- Cinnamon, Quercus, Ipecacuanha • Shredder mills- cutting and shredding • Hammer mills- grinding
Seeds and fruits	The comminution of seeds and fruits offer proves to be particularly difficult because of their content of fats and ethereal oils. Example- coffee and cocoa beans. • Shredder mills – comminution
Other drug plant materials	These include flowers, part of flowers and products such as alginates, agar, and gelatins • Shredder mills – comminution

Garbling

The next step in preparation of crude drug for market after drying is garbling which is the final step of the preparation of crude drug. The process is desired when sand, dirt and foreign parts of the same plant, not constituents are required to be removed. If extraneous matter to be removed permitted in crude drugs, the quality of crude drugs suffers and at times it doesn't pass pharmacopoeial limits. Example- 1.excessive stem in case of lobelia and stramonium need to be removed. 2. Stalks, in case of cloves are to be detected. 3. Drugs constituting rhizomes need to be separated carefully from roots and rootlets and also stem bases. 4. Pieces of iron must be removed with the magnet in case of caster seeds before crushing 5. Shifting in case of vinca and senna leaves. 6. Pieces of bark should be removed by peelings as in gum acacia.

Packing

The morphological and chemical nature of the drug, its ultimate use and effect of climatic conditions during transportation and storage should be taken into consideration while packing of drugs.

- Colophony and balsam packed in kerosene tins.
- Asafoetida is stored in well-closed container to prevent loss of volatile oil.
- Cod liver oil is sensitive to sunlight so it should be stored in such containers, which will not affect the sunlight.
- Leaf drug like senna, vinca are pressed and baled.
- Drug which very sensitive to moisture and costly at the same time need special attention. Example- digitalis, ergot, squills
- Colophony needs to be packed in big masses to control auto oxidation.
- Crude drugs like roots, seeds and other part packed in gummy bags.
- Weight of certain drug in lots also kept constant Example- Indian opium.

Packing material and specific storage of Raw Herbs

1. Woody in nature like stem, heartwood, bark etc. : Gunny bags and woven sacks
2. Soft in nature like creepers, leaves etc. : High gauge HMHD bags, woven sacks with LD liner, High gauge polyethylene bags
3. Fleshy in nature like fruits, rhizomes etc.: High gauge HMHD bags, woven sacks with LD liner, wooden boxes.
4. Flowers, anthers, stigma, petals, seeds etc. : Corrugated box with polypropylene woven sacks, HDPE containers, Fiber board's drums
5. Volatile contents: Air tight HDPE containers, Air tight HDPE carboys, Card board box with polyethylene liners
6. Herbal extracts and compounds: Air tight HDPE containers, corrugated box with polyethylene woven sacks and fiber board's drums with polyethylene bags. HDHM (High molecular weight high density polyethylene), LD liner (Low density liner bags), HDPE (High density polyethylene)

Storage of Herbal Raw Drug

- Proper storage and preservative are important factors in maintaining a high degree of quality of the drug.
- Warehouse should preferably be of fire proof, steel, concrete or brick construction, and unheated and rodent proof.
- Hard packed bales usually reabsorb little moisture. This is also true of barks and resinous drug but leaf, herbs, and roots drugs that are not well packed tend to absorb moisture up to 10%, 15%, or 30% of weight of drug.

- Excessive moisture not only increases the weight of the drug. Thus reducing the % of active constituents but also favours enzymatic activity and facilitates fungal growth. Example-. Digitalis glycoside is deteriorate when moisture in the drug reaches 8% or higher.
- Liquid adversely affects drugs, which are higher colored, rendering them unattractive and possibly causing undesirable changes in constituents. It has been shown that polarized light changes more rapidly the ordinary light.
- The oxygen of the air increase oxidation of the constituent so of the drugs, especially when oxidases (oxidizing enzymes) are present.
- Insects also attack on crude herbal drugs so to prevention of their attacks a number of methods have been employed. The simple method of all being to expose the drug to a temperature of 65^{o}C. They also prevent form determination.
- The fumigation of large lots of crude drugs such as stored in warehoused and manufacturing plants, the use of methyl bromide.
- Small lots of drugs may readily be stored in air-light, moisture proof and lightproof containers.
- If drugs in small quantities are stored in air-tight containers, insect attack can be controlled by the addition of a few drops of chloroform or CCl_4.
- Certain drugs such as biologics must be stored at a temperature between 2^{o} and 10^{o}C

1.2 Biodynamic Agriculture

The term biodynamic, derived from two Greek words “bios” (life) and ‘dynamis” (energy), refers to ‘working with the energies’ which create and maintain life. The concept of biodynamic agriculture, very similar to organic farming, regards the soil as a self-sustained and biologically dynamic and biochemically active environment. Biodynamic agriculture is an alternative farm management mode, free from synthetic inputs. Biodynamic agriculture differs from organic agriculture in as much as it involves specific practices aimed at improving plant vitality by strengthening plant, ground and environmental interactions.

1.2.1 Good Agricultural Practices in Cultivation (GACP) of Medicinal Plants

Section 1: General Introduction and Glossary

Section 2: Good Agricultural Practices (GAP) for Medicinal Plants

- Identification/Authentication of Cultivated Medicinal Plants
- Seeds and Other Propagation Materials
- Site selection
- Personnel
- Ecological Environment and Social Impact
- Soil
- Climate

- Irrigation and Drainage
- Cultivation
- Plant Maintenance and Protection
- Harvest

Section 3: Good Collection Practices (GCP) for Medicinal Plants

- Permission to Collect
- Technical Planning
- Selection of Medicinal Plants for Collection
- Collection
- Personnel

Section 4: Common Technical Aspects of GACP

- Post-harvest Processing
- Inspection and Sorting
- Primary Processing
- Drying
- Specific Processing
- Bulk Packaging and Labelling
- Storage and Transportation
- Equipment
- Quality Assurance
- Documentation
- Personnel (growers, collectors, producers, handlers, processors)

Section 5: Other Relevant Issues

- Ethical and Legal Considerations
- Intellectual Property Rights and Benefits-Sharing
- Threatened and Endangered Species
- Research needs

Annexure

Annex 1. Good Agricultural Practice for Traditional Chinese Medicinal Materials, People's Republic of China

Annex 2. Points to Consider on Good Agricultural and Collection Practice for Starting Materials of Herbal Origin

Annex 3. Good Agricultural and Collection Practices for Medicinal Plants (GACP), Japan

Annex 4. A model structure for monographs on good agricultural practices for specific medicinal plants

Annex 5. Sample record for cultivated medicinal plants

Annex 6. Participants in the WHO Consultation on Good Agricultural and Field Collection Practices for Medicinal Plants

Section 1: General Introduction and Glossary

This section involves following important descriptions.

Need of GACP Guidelines

1. Interest in herbal medicines risen the issues related to safety and quality of herbal medicines
2. Inadvertent use of the wrong plant species
3. Adulteration with undeclared other medicines and/or potent substances
4. Contamination with undeclared toxic and/or hazardous substances
5. Over dosage, inappropriate use by health-care providers or consumers
6. Interaction with other medicines
7. Use of inferior quality raw medicinal plant materials results in poor quality finished products
8. Collection from wild populations leads to global, regional and/or local over-harvesting
9. Protection of endangered species
10. Impact on environment and ecological processes
11. Impact on the welfare of local communities should be considered
12. Respect of intellectual property rights

Objectives

1. Supply of good quality raw material applicable to national and/or regional quality standards thus improve the quality, safety and efficacy of finished herbal products;
2. guide the formulation of national and/or regional GACP guidelines and GACP monographs for medicinal plants and related standard operating procedures; and
3. encourage and support the conservation of medicinal plants and the environment

Structure

The guidelines are divided into five sections:

- Section 1: provides a general introduction and a glossary for relevant terms
- Section 2: good agricultural practices for medicinal plants
- Section 3: discuss good collection practices for medicinal plants.
- Section 4: outlines common technical aspects of good agricultural practices for medicinal plants and good collection practices for medicinal plants
- Section 5: considers other relevant issues

Following annexures are provided in this guideline:

- Annexure 1: national and regional documents on good agricultural practices for medicinal plants from the China

- Annexure 2: national and regional documents on good agricultural practices for medicinal plants from the European Agency
- Annexure 3: national and regional documents on good agricultural practices for medicinal plants from the Japan
- Annexure 4: model structure for monographs on good agricultural practices for specific medicinal plants
- Annexure 5: sample record for cultivated medicinal plants
- Annexure 6. Participants in the WHO Consultation on Good Agricultural and Field Collection Practices for Medicinal Plants

Section 2: Good Agricultural Practices (GAP) for Medicinal Plants

1. ***Identification/authentication of cultivated medicinal plants:*** The botanical identity – scientific name (genus, species, subspecies/variety, author, and family) – of each medicinal plant under cultivation should be verified and recorded. If available, the local and English common names should also be recorded. Documentation of the botanical identity should be included in the registration file as a specimen.
2. ***Seeds and other propagation materials:*** propagation materials should be from any disease or contamination and provide all necessary information relating to the identity, quality and performance of their products, as well as their breeding history, where possible. Materials used for organic production should be certified as being organically derived.
3. ***Site selection:*** Medicinal plant materials derived from the same species can show significant differences in quality when cultivated at different sites, owing to the influence of soil, climate and other factors. Risks of contamination as a result of pollution of the soil, air or water by hazardous chemicals should be avoided.
4. ***Personnel:*** Growers and producers should have formal or informal practical education and training of the medicinal plant concerned. This should include botanical identification, cultivation characteristics and environ-mental requirements (soil type, soil pH, fertility, plant spacing and light requirements), as well as the means of harvest, storage and personal hygiene, issues relevant to the protection of the environment, conservation of medicinal plant species, and proper agricultural stewardship. Smoking and eating should not be permitted in medicinal plant processing areas.
5. ***Ecological environment and social impact:*** The introduction of non-indigenous medicinal plant species into cultivation may have a detrimental impact on the biological and ecological balance of the region. In terms of local income – earning opportunities, small-scale cultivation is often preferable so that local communities benefit directly from, for example, fair wages, equal employment opportunities and capital reinvestment.
6. ***Soil:*** Optimal soil conditions, including soil type, drainage, moisture retention, fertility and pH, will be dictated by the selected medicinal plant species and/or target medicinal plant part. Green manure should be preferred.
7. ***Climate:*** The duration of sunlight, average rainfall, average temperature, including daytime and night-time temperature differences, also influence the physiological and biochemical activities of plants, and prior knowledge should be considered.

8. ***Irrigation and drainage:*** should be controlled and carried out in accordance with the needs of individual plant.
9. ***Cultivation:*** The conditions and duration of cultivation required vary depending on the medicinal plant materials required. Scientific and if no scientific data available then traditional methods should be used to cultivate medicinal plant.
10. ***Plant maintenance and protection:*** Timely application of measures such as topping, bud nipping, pruning and shading, Integrated pest management should be followed where appropriate
11. ***Harvest:*** The time of harvest depends on the plant part to be used. The best time for harvest (quality peak season/time of day) should be determined according to the quality and quantity of biologically active constituents rather than the total vegetative yield of the targeted medicinal plant parts. No foreign matter, weeds or toxic plants are mixed with the harvested medicinal plant materials. Avoid dew, rain or exceptionally high humidity. If harvesting occurs in wet conditions, the material should be transported immediately to an indoor drying. Use clean devices to harvest as well as to store. Material should be stored in dry and free from insects, rodents, birds and other pests, and inaccessible to livestock and domestic animals. If the underground parts (such as the roots) are used, any adhering soil should be removed from the medicinal plant materials as soon as they are harvested. Medicinal plants should not be collected in or near areas where high levels of pesticides or other possible contaminants are used or found, such as roadsides, drainage ditches, mine tailings, garbage dumps and industrial facilities which may produce toxic emissions.

Section 3: Good collection Practices (GCP) for Medicinal Plants

1. ***Permission to collect:*** In some countries, collection permits and other documents from government authorities and landowners must be obtained prior to collecting any plants from the wild. Sufficient time for the processing and issuance of these permits must be allocated at the planning stage. For medicinal plant materials intended for export from the country of collection, export permits, phytosanitary certificates, Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) permit(s) (for export and import), CITES certificates (for re-export), and other permits must be obtained, when required.
2. ***Technical planning:*** Essential information on the target species (the geographical distribution and population Density, taxonomy, distribution, phenology, genetic diversity, reproductive biology and ethnobotany) should be obtained. Data about environmental conditions, including topography, geology, soil, climate and vegetation at the prospective collecting site(s), should be collated and presented in a collection management plan. Transport, personnel, equipments and storage facilities should be ready.
3. ***Selection of medicinal plants for collection:*** select and authenticate plant species for collection.
4. ***Collection:*** same as above given in GAP
5. ***Personnel:*** same as above given in GAP

Section 4: Common Technical Aspects of GACP

1. **Post-harvest processing:**
   - **(a) Inspection and sorting:** Raw medicinal plant materials should be inspected and sorted for foreign matter, cross contamination and organoleptic characters prior to primary processing.
   - **(b) Primary processing:** Harvested or collected raw medicinal plant materials, prior to processing, should be protected from rain, moisture and any other conditions that might cause deterioration.
   - **(c) Drying:** Medicinal plants can be dried in a number of ways: in the open air (shaded from direct sunlight); placed in thin layers on drying frames, wire-screened rooms or buildings; by direct sunlight, if appropriate; in drying ovens/rooms and solar dryers; by indirect fire; baking; lyophilization; microwave; or infrared devices. When possible, temperature and humidity should be controlled to avoid damage to the active chemical constituents. The method and temperature used for drying may have a considerable impact on the quality of the resulting medicinal plant materials.
   - **(d) Specific processing:** Common specific processing practices include pre-selection, peeling the skins of roots and rhizomes, boiling in water, steaming, soaking, pickling, distillation, fumigation, roasting, natural fermentation, treatment with lime and chopping. Processing procedures involving the formation of certain shapes, bundling and special drying may also have an impact on the quality of the medicinal plant materials.
   - **(e) Processing facilities:** Facilities should preferably be located in areas that are free from objectionable odours, smoke, dust or other contaminants, and are not subject to flooding. Roadways should not be near vicinity, building ceilings, floors should be clean. Sufficient lighting, ventilation and water supply should be maintained.
2. ***Bulk packaging and labelling:*** immediate packing and labelling is necessary. Packaging material should be clean and stored in dry places. Appropriate labels should be affixed to each batch packing.
3. ***Storage and transportation:*** Conveyances used for transporting bulk medicinal plant materials from the place of production to storage for processing should be cleaned between loads. Bulk transport, such as ship or rail cars, should be cleaned and, where appropriate, well ventilated to remove moisture from medicinal plant materials and to prevent condensation.
4. ***Equipment:*** should be clean and well labelled
5. ***Quality assurance:*** regular auditing visits to cultivation or collection sites and processing facilities by expert representatives of producers and buyers and through inspection by national and/or local regulatory authorities.
6. ***Documentation:*** SOP should be prepared for each stage.
7. ***Personnel (growers, collectors, producers, handlers, processors):*** same as GAP

Section 5: Other Relevant

Issues

5.1 Ethical and legal considerations*:* Must be carried out in accordance with legal and environmental requirements and with the ethical codes or norms of the community and country in which the activities take place. The provisions of the Convention on Biological Diversity must be respected.

- ***Intellectual property rights and benefits-sharing:*** Agreements on the return of immediate and/or long-term benefits and compensation for the use of source medicinal plant materials must be discussed and concluded, in writing, prior to collection or cultivation.
- ***Threatened and endangered species:*** Medicinal plants that are protected by national and international laws, such as those listed in national "red" lists, may be collected only by relevant permission according to national and/or international laws.

5.2 Research needs

A national and/or regional inventory of medicinal plants may facilitate the identification of medicinal plants used by communities (including endangered species), outline their distribution and assess their abundance. It can also be used as a tool in tackling questions concerning intellectual property rights issues. Member States are encouraged to establish such inventories.

Research is greatly needed to improve the agronomy of cultivated medicinal plants, promote the exchange of information on agricultural production and investigate the social and environmental impact of medicinal plant cultivation and collection.

Data sheets and monographs should be developed on medicinal plants that take into account the particular situation of regions and countries. Such information materials can be useful instruments for promoting technical advancement. General as well as specific education and training materials should be developed for local growers and collectors of medicinal plants.

1.2.2 Organic Farming

Biodynamic agriculture is a holistic, ecological, and ethical approach to farming which focuses exclusively on organic farming. It avoids use of inorganic and synthetic chemicals, pesticides and fertilizers. It favors traditional farming with use of modern technology.

Organic farming is an agricultural system that uses fertilizers of organic origin such as compost manure, green manure, and bone meal and places emphasis on techniques such as crop rotation and companion planting.

Integrated Pest Management is important aspect of organic farming which involves:

- *Cultural method or traditional methods like clean cultivation without giving chance to spread pest, crop rotation and plowing, variation in time of planting, proper use of fertilizers and irrigation, use of resistant varieties, intercropping, pruning*
- *Mechanical, physical control or biological control like use of pheromones and hormones; use of attractants, repellants and sterilants*
- *Use of biopesticides like fungi (Beauveria, entomophthora), bacteria (Bacillus thuringiensis), Virus (Nuclear polyhedrosis Virus),*
- *Use of botanical pesticides like neem, pyrethrin*

The principal methods of organic farming include

- **Crop rotation**: It is the practice of growing different types of crops in the same area in sequenced seasons. Different crops need different nutrients. Depletion in soil nutrition is observed due to growing of same crops in the same place for many years due to use of only one type of nutrient by crops. But rotation of crops can balance soil nutrition by reducing soil erosion and increasing soil fertility and crop yield.
- **Use of green manures**: Green manure comprises cover crops which are grown only for production of green manures. These crops in green condition are allowed to incorporate in soil by ploughing to improve soil nutrition and fertility.
- **Use of compost**: Composting of waste is an aerobic (in the presence of air) method of decomposing solid wastes. The process involves decomposition of organic waste into humus known as compost which is a good fertiliser for plants. Vermi-compost is excretions produced by live earthworms in soil provided with sufficient biomass. Use of bio fertilizers (example: *Rhizobium*, *Azotobactor*, Blue green algae, Azolla , *Mycorrhizae* etc) and kitchen waste are also promising in improvement of soil fertility.
- **Mechanical control:** It employs manual labor along with different devices for collection and destruction of pests.
- **Biological pest control**: Biological control is a method of controlling pests such as insects, mites, weeds and plant diseases using other organisms. It relies on predation, parasitism, herbivorism, or other natural mechanisms like use of herbivores and pathogens, but typically also involves an active human management role. It requires thorough understanding of effective organisms. There are three basic types of biological pest control strategies:
  - Importation: use of natural enemy of a pest
  - Augmentation: breeding and release of locally-occurring natural enemies
  - Conservation: use of measures to increase natural enemies

Due to popularity of medicinal plants for primary health care and prevention of diseases, natural resources of these plants are destroyed by human being. But sound knowledge of Cultivation technology has resulted in gradual depletion of raw material from wild sources. Cultivation of medicinal plants requires knowledge, skills, and technologies used to grow intensively produced plants for human food and non-food uses and for personal or social needs. Actual work involves plant propagation and cultivation with the aim of improving plant growth, yields, quality, nutritional value, and resistance to insects, diseases, and environmental stresses. Wild medicinal plant collection damages natural environment due to extinction of a species and many times it is difficult to collect correct plant from remote areas like mountains, forests etc. So cultivation of medicinal plants allows preservation of endangered medicinal plants and thus natural resources improves quality and quantity as well as yield of drugs and builds up national economy.

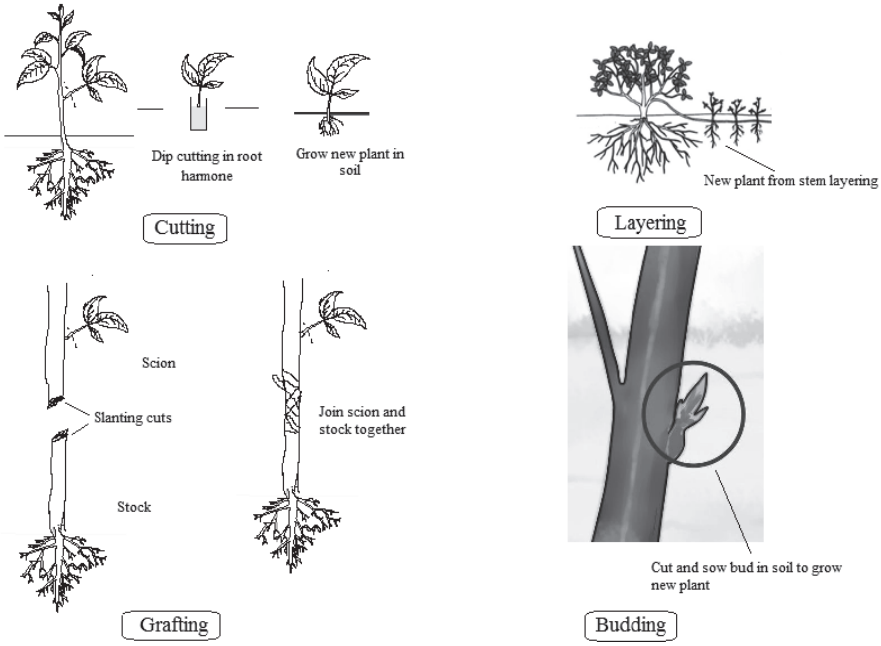

Fig. 1.1 Different Asexual (vegetative) propagation methods

Following are Methods of propagation

Method	Sexual (seed) propagation	Asexual (vegetative) propagation (Fig. 1.1)		
Material of propagation	Seeds are sowed by broadcasting (scattering of extremely small seeds) or dibbling (sowing of large size seeds into holes) method	**Natural**: Bulbs (garlic), tubers (aconite), offsets (aloe), corms (saffron), rhizomes (ginger), roots, suckers (banana), stolons (licorice)	**Artificial**: Cuttings (rose, brahmi), layering (lemon), grafting (mango), budding (hibiscus)	**Tissue culture**: Laboratory developed cultures of plants (Example: Banana)
Advantages	Cheap method of raising Seedlings which are long-lived, sturdy and suitable for plants which cannot be propagated by asexual method	Uniformity in yield and other characters, fast in growth, seedless, nutrients improved or disease resistant varieties can be obtained		
Disadvantages	Time consuming and costly as to grow seed-lings first and then actual plant, poor uniformity in yield of seedlings,	Poor adaptability to climatic changes and hence short lived		

1.2.3 Pest and Pest Management in Medicinal Plants

Pest is an undesirable animal or plant species. The overall losses due to pest infestation tune to millions of rupees every year. The control of pests thus, assumes primary importance in the context of cultivation of medicinal and aromatic plants. Pest control in the recent years has become a major problem in our homes, gardens and agriculture. The insect population of the universe is increased to such an extent that governmental agencies and public health offices are constantly struggling to keep barest of this potential danger to crop plant. The different types of pests infesting the medicinal plants are: fungi, virus, Insects, Weeds, Non insect pests

Fungi: Many fungi affect plants differently. Here few examples are discussed

- Aschochyta atropea: Formation of grayish white irregular spots which further cause necrosis of leaves, called leaf necrosis
- Cercospora atropea: Round to angular brown spots with chestnut coloured margins on both sides of leaves, called leaf spot.
- Phytophthora nicotinae: Dropping of young leaves and branches, yellowing of older leaves and drying of whole apical portion, called phytophthora root rot. (disease most occur on belladonna and some other plants)

Viruses: Many different viruses are also the cause of the some disease occurring on plants. They are mosaic causing necrosis of leaves, petioles and stem on different solanaceous plants. Tobacco mosaic virus, Cucumber mosaic virus, Tobacco ring spot virus affects Digitalis. Cucumber mosaic virus (one of the strain) affects hyocymus, rauwolfia, tobacco, datura, vinca and eucalyptus. Other viruses are Yellow vein mosaic, graft transmissible virus, distortion mosaic etc.

Insects: It is found that Total no. of insect species are equivalent to **Total** number of species of all other forms of life put together. Throughout world, about 1 million insect species have been reported. All insects are belongs to Arthropods of animal kingdom. These arthropods are roughly divided into two morphological groups, according to their Mouthparts. Their effects involve biting, chewing**,** piercing and sucking. Various insect pests which attack medicinal plants are: Agrotis spes., Heliothis armigera, Odoutotames obesus, Flea beetle, Empoasca pteridis etc.

- Mentha: Phytomyza atricornis
- Rauwolfia: Diaphonia nilgirica, Indomia cretacerus, Plantia viridicolis
- Dill: Papillio machon, Hyadaphis coriavdri
- belladona leaves: Gonocephalum spc., Agrotis flammatra
- Others, which cause damages, are caterpillar, lepidopterus larve, weevil, aphids, pyrilla, locusts, spinder, ticks, mites etc.

Weeds: A weed is undesirable plant. Weeds are considered as dreadful pests because losses due to them estimated to be more than those occurring due to pests and disease combination together. Weed leads to loss of Nutrients**,** Water**,** Light and space. Increase in cost of labour and equipment. Low product quality**,** Enhanced chances for attacks of bacteria, fungi and insects, Some weeds also cause allergies:

- Hay fever by Rag weed, Medican tea, Yellow dock, Parthenium
- Dermatitis by Poison ivy, Western poison oak, Poison sumac
- Others, Fatal effect by Corn cokle (cyanogenetic glycoside), Poisonous: Datura, menispermous spc.

Non-Insect Pests: They are grouped into two categories. Vertebrates like monkeys, rats, birds, rabbits and hares, squirrels, antelopes, deer, pigs. Ievertebrates like nematodes, crabs, snails, mites and symphylids.

Methods of Pest Control

Mechanical Method	It employs manual labor along with different devices for collection and destruction of pests. A proper approach is made for collection and destruction of Eggs, Larvae, Pupae, and Adults of insects. The better way for protection from rodents like rat is construction of concrete warehouses. Warehouses should have metal reinforcement corners on window frames. The method adopted for trapping flying insect is flavored attractant placed in funnel shaped container, which are mixed with saw dust. The insect can easily get an entry in the trap, but find very hard to come out. The mouse and rat traps are also used. The simple techniques used are: Hand picking, Pruning, Burning, Trapping of pests. ***Advantage*** • Skilled labours are not required • Cost required is very less • There are no any side effects ***Limitations*** • Time and labour requirement is high • Applicable only on small scale • Requires repeated application
Physical Method	Reduction of pest population by using device which affect them physically or alter their physical environment. Manipulation of temperature, humidity, light is used for this purpose. This includes following types: • Sun drying:. • Disinfection of gowdouns by heating [50-70^{0}C] • Burning • Refrigeration/Cold storage • Moisture: [less than 10 %] • Use of light • Use of Ionizing radiation to sterile • Use of Ultrasonic sound • Hot water
Cultural/*Agricultural Method*	It covers advanced plant breeding techniques capable of inducing genetic manipulations resulting in production of pest-resistance species. It has achieved much success in producing hybrid varieties, which are resistance to fungal and bacterial attack, as compared to limited success with insect. The systemic insecticides have been developed which are absorbed through the root and reach to leaves by which all the foliage portion becomes distasteful for insects. Another aspect is agricultural control is ploughing, which should be sufficiently deep so as to eradicate weeds as well as early stages of insects. If a plant is found out to be favored by insects as

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	major source of food, the land under cultivation of such plant should be subjected to crop rotation. Another method for checking supply of food to insects is by changing the environment which is in many cases, may leads to obstruction in their life cycle. Proper drainage source serve this purpose to a greater extent. ***Advantages*** • Economic • Safe ***Disadvantages*** • Effective for single pest only • Few visible results observed • Not effective at epidemic condition • Detailed knowledge of biology of pest is required
Chemical Method	Chemical control is done by with help of Pesticides. Pesticides are chemicals derived from synthetic and natural sources effective in small concentration against pest. Because of toxic effect of all such chemicals used as pesticides their use is regulated by the **Insecticides** act, in India; Federal insecticide, fungicide and rodenticide act, in US**;** The agriculture (poisonous substances) regulation, in UK**.** Various forms of preparation of pesticides used:Spray or wetable powders, Powders, Granulates, Self-emulsifying concentrates, Solution in mineral oil fractions, Fumigants. Chemical Pesticides may be classified according to the type of organism against which they are effective, as follows ***Fungicides:*** they are used to prevent or control the plant disease caused by phytopathogenic fungi and most widely used as seed or soil fungicidal disinfectant. They can be of different types based on their use as follows: *Disinfectants for seeds:* These fungicides give prior protection to seeds against fungal disease causing pathogens which are admixed with the seed in the form of their spores, hyphae and scieratia. Dithiocarbamates, Organo-phosphorous compounds, Pyridine derivatives, Carboxins etc. *Disinfectants for soil:* There are some fungicides, which can be useful for the disinfection of the soil and thereby kill the phyto-pathogenic bacteria, which cause fungal infection through soil. However this is more difficult and expensive. *Leaf fungicides:* These are fungicides, which are used for the protection of the leaves and fruits. Bordeaux mixture, Copper oxy chlorides, Colloidal sulphur, Barium sulphate, Thiurams and dithiocarbamates, Nitro compounds like dichloro nitro aniline etc ***Herbicides:*** They are the weed killers, which are used for destroying the unwanted plants or to prevent their growth. Example- Carbamates, Urea derivatives, Growth promoters, Quaternary ammonium compounds, Di-and triazines. They are of several types that differ in their mode of action as: Total herbicides, Selective herbicides, Water weed killers, Harvesting aids ***Insecticides:*** Major insect controlling agents are insecticides, insect repellents, insect attractant and insect sterilizing agents. The insecticides can be of three types like Respiratory toxin or food toxin or contact toxins. Beside these they can be classified by the mode of action as general cell toxins (protein precipitants), enzyme toxins (phosphoric acid ester and N- alkyl carbamates) and nerve toxins (Example-chlorinated hydrocarbons). The insecticides used for the protection of the medicinal plants can be of two types based on the site of their action those which do not penetrate into the plant and systematic insecticides. ***Acaricides*****:** They are substances that are used to control the infestation caused by the mites, especially spider mites. These mites belong to the arthropod and multiply very

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	rapidly. They cause rapid damage to the foliage of culti-vated plants. These insects acquire resistance to the chemicals because of their rapid multiplication and therefore new acaricides have to be developed. Examples: Phosphoric and thiophos-phoric acid esters, Carba-midic esters, Chlorinated aromatics with or without sulphur in the molecule ***Nematodes*:** For the control of the phyto-pathogenic thread worms i.e. nematodes living free in the soil and also occurring in the plants. The agents, which are responsible for the control of the nematodes, are Halogenated hydrocarbons, Carbamidic and thiocarbamidic acid derivatives and Thio-phosphoric acid esters ***Rodenticides*:** Rodents are the mammals such as the rats, mouse and rabbit, which have sharp gnawing incisor teeth. The fecal pellets and hairs from the fur of the rats and mice characterize this contamination. The pesticides acts against rodent are called rodenticides. Examples: Warfarin, Arsenic trioxide, Thallium sulfate ***Advantages*** • Highly effective method • Get quick results • Useful at variable climatic conditions • Wide range for selection of chemicals • Economic method ***Disadvantages*** • Repeated application of chemicals is required • Non target species like natural enemies of insect get affected. • Resurgence of minor pest • Residue in food • Direct hazard to the applicator • Resistance in insect
Biological Control Biopesticides/ Bioinsecticides	See details as follows

1.2.4 Biopesticides/Bioinsecticides

This method uses biochemicals, microorganisms or plant mediated pest control. If the method is properly designed it may emerge as an effective, safe, and economical method of pest control.

Biochemical pesticides: It include substances that interfere with mating, such as insect sex pheromones (Examples- 7, 8-epoxy-2-methyloctadecane from gypsy-moth), as well as various scented plant extracts that attract insect pests to traps.

Plant derived Biopesticides/Bioinsecticides: The reason for using new natural pesticides is that these are active at highly acceptable levels, biodegradable and do not leave toxic residues while the commonly used phosphorous and chlorinated insecticides contaminate the environment. [Table 1.2.]

Microbial pesticides: It consists of a microorganism (Example- a bacterium, fungus, virus or protozoan) as the active ingredient. Microbial pesticides can control many different kinds of pests, although each separate active ingredient is relatively specific for its target pest[s]. For example, there are fungi that control certain weeds and other fungi that kill specific insects. The most widely used microbial pesticides are subspecies and strains of *Bacillus thuringiensis,* or

Bt. Each strain of this bacterium produces a different mix of proteins and specifically kills one or a few related species of insect larvae.

Predators: Organisms which feed on other insects having body size greater or equal to the insect is called predators. This includes,

- Lady bird beetle: This insect feeds on aphids.
- *Chrysoperia carnea*: The larvae of this insect feed on all soft bodied insects like aphids, jassids, white flies, mealy bug, etc.
- *Cryptolaemus montrouzieri*: This insect feeds on mealy bugs on grapes.

Parasites: Those insects whose larvae feed internally or externally on the body of other insect is called parasites. This includes,

- Egg parasite: Trichogramma chilonis parasites egg of Helicoverpa armigera.
- Larval parasite: Bracon hibitor parasites larvae of H.armigera.
- Pupal parasite: Goniopthalmus halli parasites pupae of H.armigera.
- Adult parasite: Epiricania melanoleuca parasites adults of sugarcane pyrilla.
- Egg larval parasite: Copidosoma kohleri parasities egg of potato tuber moth and comes out at larval stage by killing the pest.

Pathogens: Microorganisms like bacteria, virusus, fungi, protozoa and nematodes develop diseases to the pest and thus help in killing pest. [Table 1.3]

Table 1.1 Different Classes of Pesticides based on the Chemical Composition

Class	Examples	Action on plants	Action on animals
Chlorinated hydrocarbons	Aldrin, Benzene hexachloride (BHC), Chlordane, DDT, Dieldrine, Endrin, Heptachlor, Lindane , Methoxychlor	➢ Inhibition of photosynthesis ➢ Inhibition of oxidative phosphorylation	➢ Inhibition of Ach esterase ➢ Neurotoxication
Chlorinated phenoxyalkanoic acid	2, 4- D (2, 4- dichlorophenoxy acetic acid), 2, 4, 5- T		
Organophosphorous	Carbaphenathion, Malathion, Parathion, Demeton, Ethion		
Carbonate insecticides	Carbaryl	➢ Hormone analogue ➢ Inhibition of chlorophyll synthesis ➢ Inhibition of pentothenate synthesis	➢ Inhibition of neuromuscular junction
Dithiocarbamate fungicides	Ferbamn, Nabam, Thiram, Zineb, Ziram		
Inorganic pesticides	Alumminium phosphate, Calcium arsenate, Lead arsenate		
Miscellaneous	Brompropylate, Chloropicrin, Ethylene dibromide, Ethylene oxide, Methyl bromide		
Pesticides of plant origin:	Nicotine, Pyrethrum, pyrethroids, Rotenoids		

Table 1.2 Examples of Plant derived Biopesticide/Bio-insecticides

Pyrethrum (African daisy)	Biological source: dried flower heads of *Chrysanthemum cinerariifolium* and *Chrysanthemum coccineum* of family Asteraceae. It contains oleoresin mixture of six compounds: Pyrethrin-I and II, Cinerin-I and II, Jasmoline-I and II *Mode of action*: It is contact poison which affects on CNS through sodium channel and causes paralysis
Sabadilla lily	*Biological source:* seeds of *Schoenocaulon officinale* of family Liliaceae. It contains vetratridine, sabadine alkaloids. *Mode of action:* It is contact poison and affects on CNS through sodium channel and causes paralysis
Castor oil	*Biological source:* seeds of *Ricinus communis* of family Euphorbiaceae. It contains toxic protein ricin. *Mode of action:* Impairs chain elongation in protein synthesis, causing cell death and tissue damage
Ryania	*Biological source:* Roots of *Ryania specios* of family Salicaceae. It contains diterpene alkaloid- ryanodine *Mode of action:* Affects CVS, CNS by inhibiting calcium release proteins
Derris (tuba) root	*Biological source:* Root and rhizomes of *Derris elliptica* of family Fabaceae. The main active principle is iso-flavonoid rotenone. *Mode of action:* It is inhibitor of respiratory chain and affects by inhibiting electron transport and thus exhibits feeding deterrent activity.
Neem	*Biological source:* Whole plant of *Azadhiracta indica* of family Meliaceae. It contains triterpenoid- azadirachtin *Mode of action:* Anti-feedent, antifungal, nematicidal, affects hormones of insects
Nux vomica	*Biological source:* Seeds of *Strychnous nux-vomica* of family Loganiaceae. It contains indole alkaloids –Strychnine and Brucine. *Mode of action:* Rodenticide by strong convulsant action
Red squill	*Biological source:* Bulbs of *Urginia maritima* of family Liliaceae. It contains cardioactive sterols- proscillaridin, scillroside, scillarenin *Mode of action:* It causes emesis, blocks cardiovascular and central nervous system.
Tobacco	*Biological source:* Whole plant of *Nicotiana tabacum* of family Solanaceae. It contains alkaloid- Nicotine *Mode of action:* It predominantly affects respiratory system but also acts as a slight contact and stomach poison.
Custard apple	*Biological source:* Seeds of *Annona squamosa* of family Annonaceae. It contains alkaloid, essential oils and glycosides. *Mode of action:* It is cytotoxic and causes electron transport inhibition.
Essential oil	There are many well known essential oils (like ocimum, lemon grass, citronella, clove, thyme, mint, cinnamon, rosemary etc) which have insecticide or insect repellent properties. Insecticide linalool (present in ocimum, coriander, cinnamon, lavender and birch oil) has been demonstrated to act on the nervous system. Eugenol (Present in clove, cinnamon, tulsi oil) mimics octopamine action by increasing intracellular calcium levels to act as insecticide. Eugenol and its derivatives, safrole and its derivatives are found potent toxic and repellent to *Periplaneta americana (American cockroach)*. Mustard oil from *Brassica nigra* contains allyl isothiocyanate which is antifungal.

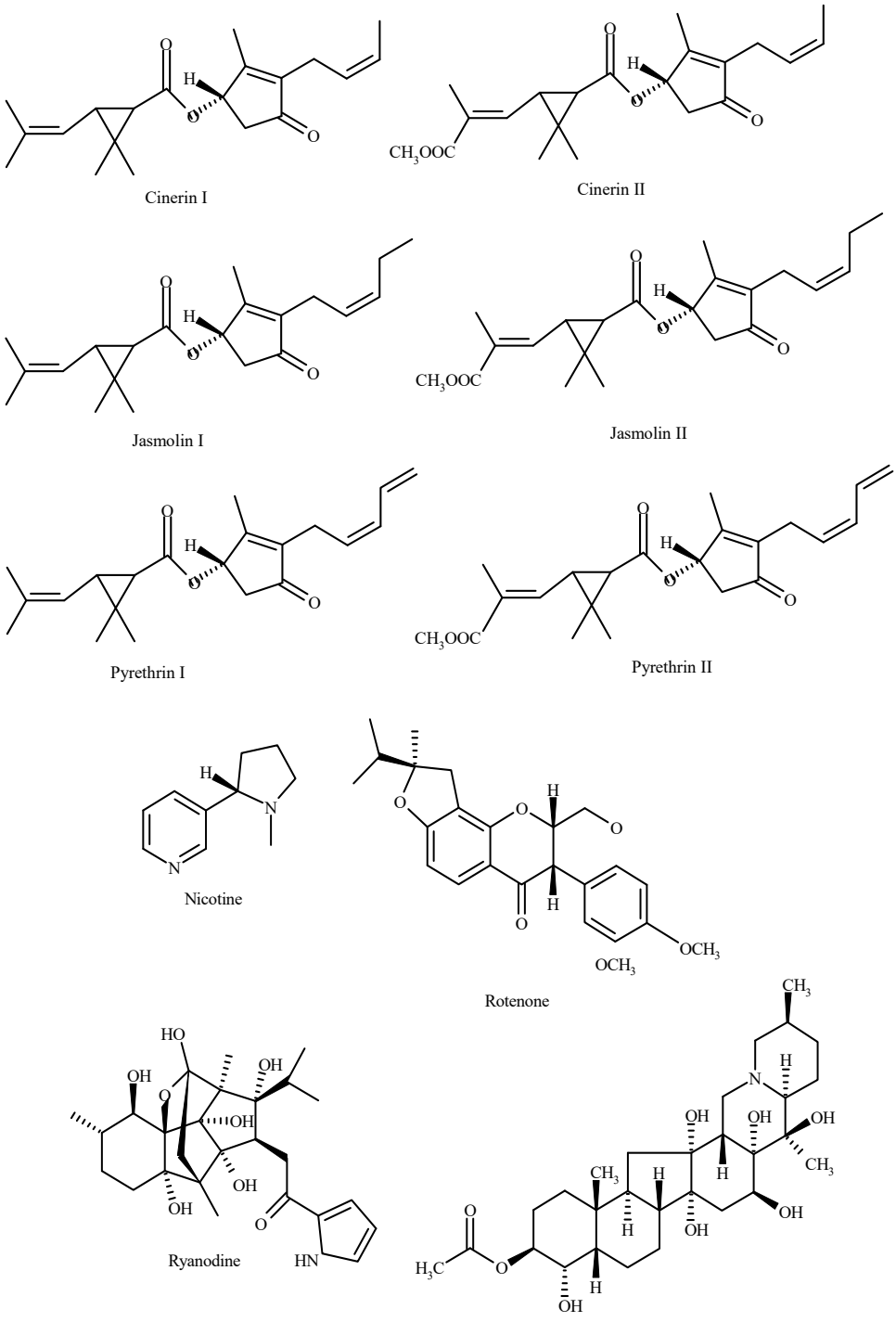

Fig. 1.2 Chemistry of natural pesticides

Table 1.3: Examples of Pathogen derived Biopesticide/Bio-insecticides

Control Agent	Mode of Action	Examples	Control Agent
Bacteria	Produce toxins that are detrimental to certain insect pests when ingested	Bacillus thuringiensis (BT)	Lepidopterans
		Bacillus popilliae	Japanese beetle
		Agrobacterium radiobacter	Crown gall disease
Viruses	Kills insects when ingested. Insect's feeding behavior is disrupted thus it starves and dies.	Baculoviruese: Nuclear polyhedrosis virus (NPV)	Lepidopteran and Hymenopteran
		Baculoviruses: Granulosis virus (GV)	Lepidopteran
		Baculoviruese: Group C	Arthropods
		Entomopo	
Fungi	Controls insects by growing on them secreting enzymes that weaken the insect's outer coat, and then getting inside the insect and continuing to grow, eventually killing the infected pest	Entomophaga praxibulli	Grasshoppers
		Zoophthora radicans	Aphids
		Neozygites floridana	Cassava green mite
Protozoa	Kills insects when ingested. Insect's feeding behavior is disrupted thus it starves and dies.	Nosema	Grasshoppers
		Vairimorpha	Lepidoptera
		Malamoeba	Locusts
Nematode	They kill their target organisms by entering natural body openings or by penetrating the insect cuticle directly.	Heterorhabditis bacteriophora	Black vine weevil, Japanese beetles
		Phasmarhabditis hermaphrodita	Various slugs and snails

1.3 Indian Systems of Medicine

1.3.1 Basic principles involved in Ayurveda, Siddha, Unani and Homeopathy

1.3.1.1 Ayurveda System

It is about 5000 year old system of medicine native to India. It is holistic system of medicine which considers whole body while treating disease and not just a diseased part of body. Ayurveda has thousands year's evidence based history so it can be just complete system rather

alternative system or complementary system. Ayurveda is a Sanskrit word which means (*Ayur*-life and *veda* – to gain knowledge or science) science of life. Ayurveda deals with different types of plants, minerals and animal products. Charak samhita by Charak includes the principle components or theory of Ayurveda. Sushrut samhita edited by Sushrut is about the surgical treatments in Ayurveda.

It is assumed that Sushruta was born in the Eastern part of India near Bihar (which was famous for sacred schools and universities at that time). Sushruta was a physician by occupation. In Mahabharata, he is represented as a son of Rishi Visvamitra.

His Samhita, divided into six volumes, compromises all aspects of general medicine. However, due to an extraordinary accuracy and detail of surgery in his work, he is also considered as the father of surgery.

These six volumes contain 184 chapters describing 1120 illness, 700 medical plants, 64 drugs prepared from minerals, and 57 from animal sources. It also discusses different surgical techniques suitable for different body parts along with 14 different types of bandages. Mostly, the Samhita focuses on surgery and midwifery, but it also deals with topics such as genetics, mental illness, embryology, anatomy, geriatric illness, and diabetes.

It has 300 surgical procedures and it classifies surgery into five subheadings such as

- Aharya (extraction of solid bodies),
- Bhedya (excising),
- Chhedya (incising),
- Eshya (probing),
- Lekhya (scarifying),
- Sivya (suturing),
- Vedhya (puncturing), and
- Visravaniya (evacuating fluids).

It describes more than 300 kinds of operations that call for 42 different surgical processes and 121 different types of instruments. For the purpose of anesthesia, he advised the use of wine with the incense of cannabis and this is the oldest form of anesthesia used with no world record before that. The instruments used for surgeries were constructed after the shape of beasts and birds and named after them like the crocodile forceps and hawk's bill forceps.

The Sushruta Samhita is best known for its approach and discussions of surgery. It was one of the first in human history to suggest that a student of surgery should learn about human body and its organs by dissecting a dead body. It describes haemorrhoidectomy, amputations, plastic, rhinoplastic, ophthalmic, lithotomic and obstetrical procedures.

Theory and principles: Ayurveda involves following fundamental principles:

Pancha Mahabhuta	*Prithvi* (earth) *Apa* (water) *Tej* (fire) *Vayu* (air) *Akash* (sky)
Panchshil theory	*Rasa* : Therapeutically active substances *Guna* : Quality *Virya* : Active principle and potency *Vipaka* : The end product of digestion *Prabhava* : Actual effect of drug on body.
Sapta Dhatu theory	*Rasa* (Plasma) *Raktam* (Blood) *Mansa* (Muscles) *Meda* (Fat) *Asthi* (Bone) *Majja* (Bone marrow and nerves) *Shukra* (Reproductive fluid or Semen)
Tridosha theory	*Vatta* = *Vayu* + *akash* = respiration and mobility *Pitta* = *Agni* = digestion and metabolism *Kapha* = *Prithvi* + *apa* = lubrication of joints and stability.
Triguna	*Satva* (good) *Raja* (aggressive) *Toma* (dullness)
Ama	A Sanskrit word meaning "uncooked" or "undigested" is used to refer to the concept of anything that exists in a state of incomplete transformation.

Diagnosis: The non-equilibrium between any of above principles causes to person suffers from diseases. Mental, physical, social and spiritual welfare of human beings is considered by Ayurveda to cure the disease cause. Observation of body color, tongue, nail, eyes, pulse and investigation of blood, urine and fecal matter is criteria of diagnosing actual cause of disease.

Treatment: Panchkarma is an important treatment in Ayurveda which includes Snehan (massage), Swedan (steam), Vaman (vomit), Virechan (expulsion) and Basti (medicated enemas). The medicines are given in the form of powder (churna, bhasma), liquid (asava, arishta and taila), semisolid (leha or paka) and tablets (gutika, vati). Treatment of ayurveda involves use of drugs obtained from plant, animal and mineral sources. Ayurveda also focuses on exercise, yoga, and meditation. One type of prescription is a Sattvic diet.

Dosage forms of Ayurveda are powders (churna), bhasma (metal oxides), asava and arishtha (alcohol containing liquids), quath (extracts), gutika (pills), lep (ointment) or taila (Medicated oils).

There are eight branches of Ayurveda:

1. Kayachikitsa (internal medicine)
2. Kumarbhritya (pediatrics)
3. Trachchikitsa (psychology medicine)
4. Shalakya Tantra [ear, nose and throat]
5. Shalya Tantra (surgery)
6. Agada tantra (toxicology)
7. Rasayana tantra (geriatrics)
8. Vajikaran tantra [gynecology]

1.3.1.2 Siddha System

Sidha system of medicine is one of the oldest medical systems known to mankind even before ayurvedic system which was flourished in Vedic culture, Dravidian culture and Indus Valley Civilization. Tamil traditional medicine is origin of Siddha system and hence most of literature of this system is given in Tamil Language. 18 "Siddhas" (Spiritual persons) developed this system so it is called as Sidha. Sage Agathiyar is considered the guru of all Sidhas.

According to Palm Leaf manuscript, it is believed that it was first described by Lord Shiva to his wife Parvathy and then to their son Lord Muruga. Then he passed this knowledge to his disciple sage Agasthya. Agasthya educated 18 Siddhars. Human beings got this knowledge from 18 Siddhars. Siddhars have to get Siddhi means attainment of supernatural powers.

Theory and principles: Generally the basic principles of Siddha and Ayurveda medicine are almost similar. But siddha system explains in detail about various basic treatments of diseases while surgery like modern treatments are practiced and written in detail in Ayurveda. Like Ayurveda, Siddha medicine also, classifies physiological components of the human beings as vata (air), pitta (fire) and kapha (earth and water). Siddha system is based on 96 principles and out of these Triguna theory, i.e., vatta, pitta and kapha is more prominent. Under normal conditions, the ratio between Vatta, Pitta, and Kapha is 4:2:1, respectively.

Siddha deals with thousands of herbs, animal, mineral and metals. Siddha system believes that health is perfect state of physical, mental, social, moral and spiritual component. It is based on Andapinda Thathuvam means relationship between universe and human body. Siddhas are called as Vaithiyars.

***Diagnosis*:** A Siddha physician studies eight important things of body i.e. nadi (pulse), varna (colour), na (tongue), mala (faeces) kan (eyes), swara (voice), sparisam (touch), and neer (urine).

Guna	Personalities	Complications
Vata	Stout, black, cold and inactive healthy	Increased *Vata* shows arrogant behaviour, paralysis, heart attack.
Pitta	Lean, whitish complexion and perfectionist	Increased *Pitta* shows graying of hair, anemia and instability.
Kapha	Well built, good complexion and well behaved	Increased *Kapha* causes jaundice, heart attack.

Treatment: Siddha medicines are divided into three categories: Thavaram (Herbal), Thadu (inorganic) and Janganam (animal). Internal as well as external medicines are divided into 32 categories each separately. Pressure or massage techniques are also part of treatment and called as Thokkanam. There are 108 varma points for pressure techniques.

Treatment is classified into three categories:

- **Devamaruthuvum (Divine method):** The medicines prepared from metals and minerals come under this topic. The speciality of these medicines is a very small dose brings quick recovery even from chronic ailments. These are highly potent. Most of these medcines has no expiry date that is they can be preserved life-long. In this method use of metals and minerals medicines like parpam, chendooram, guru, kuligai made of mercury, sulphur and pashanams recommended.
- **Manuda maruthuvum (Rational method):** In this method herbal medicines like churanam, kudineer, vadagam are used. They are herbal medicines which have short definite life span. Dose may vary accordingly. They comprise of 34 types – 22 Internal medicines and 12 External medicines
- **Internal medicines :**Charu (juice), Surasam (boiling the extracted juice), Kudineer (decoction), Karkam (Raw materials prepared into paste) etc.
- **External applications :**Vedhu (Steam- therapy), Pattru (Pasting procesed raw drugs on diseased part), Ottradam (Formentation), Kattu (Like Bandaging)
- **Asura maruthuvum (surgical method):** use of surgical method, incision, excisions, use of heat or leech

Treatment in this system emphasizes preparation of fresh medicine. It is then prepared and administered with some Pathya (some restriction). Example- Day time sleeping is not allowed or some food material is restricted like chicken, mango, coconut, mustard, groundnut, almond, tobacco etc. Medicine can be kashayam (extract), churnam (powder), tailams (medicated oil), gulligai (pills), chenduram (metal), bhasmam (calcination product) and or ghritam (medicated ghee).

1.3.1.3 Unani System

This system is also called as Unani-tibb or Yunani Medicine. Arab and Persian physicians such as Rhazes, Avicenna (Ibn Sena), Al-Zahrawi, and Ibn Nafis developed this system.

Book: Ibn Sina's the Canon of Medicine. First book, “On General Means of Treatment” describes that treatments are done in three ways: “one of them is regimen and nutrition; the second, application of drugs; and the third, manual treatment, i.e., surgery”. The second book gives rather detailed pharmacological and pharmacotherapeutic characteristic of 811 drugs, among which those of vegetable kingdom constitute 594 (73.7%), of animal kingdom 118 (14.5%) and of mineral origin 99 (12.2%).

Theory and principles*:* Unani medicine involves concept of the four humours (akhlat) i.e. Phlegm (Balgham), Blood (Dam), Yellow bile (Safra) and Black bile (Sauda). These "humors" and a open air blood sedimentation test exhibits close relation where a dark clot at the bottom resembles black bile, a layer of unclotted erythrocytes resembles blood, a layer of white blood cells resembles phlegm and a layer of clear yellow serum resembles yellow bile. Abnormality in humor leads to disease condition in body.

Diagnosis: The human body is considered to be made up of seven components i.e. 1. Elements (Arkan) 2. Temperament (Mijaz). 3. Humors (Aklat) 4. Organs (Aaza) 5. Faculties (Quwa) 6. Spirits (Arwah). 7. Functions (Afaal) which have direct bearing on the health status of a person and considered by the physician for diagnosis and treatment.

In diagnosis Unani Physican (Hakim) asks a detail history and decides treatment.

Treatment*:* After diagnosing the disease, treatment involves either to eliminate cause (Izalae sabab), normalize humors (Tadeele akhlat) or to normalise tissues or organs (Tadeele aza). Method of treatment involves modification of essential pre-requisites of health (Ilaj- Bil-Tadbeer) or Panchkarma like in Ayurveda (Ilaj-Bil-Tadbeer) or pharmacotherapy (Ilaj bil advia) or surgery (Ilaj-Bil-Yad).

- Regimental therapy (Ilajbil tadbeer) – Use of exercise, climate change, massage, venesection, leaching, cupping, diet therapy etc.
- Pharmacotherapy (Ilajbil dava) – use of plant, animal and mineral origin drugs, either alone or in combination.
- Surgery (Ilajbil Yad) – Surgical intervention in treatment

As far as possible Unani medicine therapy attempts to use simple physical means to cure a disease. Some of the techniques used in Ilaj bil- Tadbir (Regimental therapy) include Hijamah (Cupping), Fasd (Venesection), Tareeq (Sweating), Idrar-e-Baul (Diuresis), Hamam (Turkish Bath), Dalak (Massage), Kai (Cauterization), Ishal (Purging), Qai (Vomiting), Riyazat (Exercise) and Taleeq (Leeching).

Unani dosage forms are-

- Solid dosage forms [Example: (Habb (pills), quers (tablet), safoof (powder)]
- Liquid dosage forms [Joshnda (decoction), Khisanda (Infusion), Arq (Distillate), Sharbat (Syrup), Qutur (Drops)]
- Semi-solid dosage forms [Huqna (enema) and tila (liniment)].

1.3.1.4 Homeopathy System

Homeo means similar and Pathos means suffering so homeopathy is the “system of similar suffering”. German physician Samuel Hahnemann first stated the basic principle of homeopathy in 1796, known as the "law of similars" (let like be cured by like.")

This system was developed by Dr Samuel Hahnemann in Germany. Dr Samuel had written a book *The Curative Powers of Drugs and Some Examinations of Previous Principles* which was based on his study of effect of *cinchona* on his own body where he actually found “law of similars” which indicates similarity between drug and disease.

Theory and principle: Homeopathy emphasises the root cause of the disease and the nature’s law of its cure that is ‘like cures like’. Thus, homeopathy deals with the following seven principles which are outlined below:

- ***Individualisation*** : No two individuals in the world are alike, i.e. the disease affecting two individuals cannot be similar though they may share common symptoms. So the medicines used to cure the same disease in different individuals are different.

- ***Principle of similiar***: Use of the medicine will produce similar symptoms of disease in an healthy individual. For example, watery eyes and burning nose caused by an onion hence an attack of hay fever with watering eyes and a burning nose can be cured homeopathic remedy made from onion.
- ***Principle of simplex***: Only one single simple medicine at one time and no combination is allowed.
- ***Minimum dose*** : Minimum medicine at a time
- ***Law of proving***: Medicine should have the capacity to produce disease state in a healthy individual.
- ***Law of dynamisation***: Medicine should preserve the normal state of healthy body.
- ***Vital force:*** Medicine should have the capacity to arouse sufficient energy to maintain a healthy body.

Diagnosis*:* It involves knowing of complete hereditary history as well as observation of moods, habits, skin, eyes, tongue, blood, urine etc of patients.

Treatment:

Not considering imponderabilia, the source materials for homeopathic medicines may consist of the following:

- **plant material such** as: roots, stems, leaves, flowers, bark, pollen, lichen, moss, ferns and algae;
- **microorganisms** such as: fungi, bacteria, viruses and plant parasites;
- **animal materials** such as: whole animals, animal organs, tissues, secretions, cell lines, toxins, nosodes, blood products;
- **human materials such** as: tissues, secretions, cell lines and endogenous molecules such as hormones;
- **minerals and chemicals**.

When the symptoms picture matches with the drug picture, the physician always attempts to identify a single medicine. Homeopathic preparation involves "dynamisation" or "potentiation", whereby a substance is diluted with alcohol or distilled water and then vigorously shaken in a process called "succussion". Three logarithmic potency scales are in regular use in homeopathy for dilution. Hahnemann created the "centesimal" or "C scale", diluting a substance by a factor of 100 at each stage. Inert substance like sugars, typically lactose, is used to prepare homeopathic pills and then a drop of liquid homeopathic preparation is placed on pills. Hahnemann began to test what effects substances produced in humans, a procedure that would later become known as "homeopathic proving".

Imponderabilia: Homeopathic medicines prepared from energy, emanating from natural and physical reactions. It means “not weighable”, i.e. which have no perceptible weights. They are energy forms such as sunlight (Sol), magnetic fields (Magnetis Polus Australis), radiation (X-ray).

Mother solution (also called solution): the most concentrated solution prepared from a substance of mineral or chemical origin by dissolving it in alcohol or purified water. It may also be prepared by exposing alcohol or purified water to an energy source (see Imponderabilia).

Mother tincture (also called tincture): The initial homeopathic preparation made from source material that can be further potentized (also called "liquid stock"), sometimes used as homeopathic medicines, is regarded as the most concentrated form of a finished homeopathic medicine. Mother tinctures are obtained classically by maceration or percolation (sometimes also by digestion, infusion, decoction or fermentation) techniques from source materials according to a procedure prescribed by a recognized homeopathic pharmacopoeia. Sometimes a mother tincture corresponds to the first decimal dilution, "1D" or "1X" (10-1), mostly when dry plant material is used as starting material.

Nosodes: Homeopathic medicines prepared from disease products from humans or animals; from pathogenic organisms or their metabolic products; or from decomposition products of animal organs.

Sarcodes: Homeopathic medicines made from healthy animal tissues or secretions. In Greek, sarcode means fleshly.

Potency: The denominated degree of serial trituration or dilution and succession that is reached for each homeopathic medicine. The degrees of dilution or potencies are normally indicated by the letters D, DH or X for successive 1 to 10 (decimal) dilutions, the letters C, CH or K or CK for successive 1 to 100 (centesimal) dilutions while Q or LM denote successive 1 to 50 000 (Hahnemannian quinquagintamillesimal) dilutions.

Dilution by 1 to 10 denotes 1 part processed with 9 parts of diluent (Hahnemannian decimal), dilution by 1 to 100, 1 part processed with 99 parts (Hahnemannian or Korsakovian centesimal), and so on.

The number preceding the letters (Example- D, C or LM) normally indicate the number of dilution steps employed.

As a consequence of different views in various approaches in homeotherapy and because the notion of these terms may depend on the nature of the starting materials, the terms "high potency" and "low potency" cannot be defined unambiguously.

Potentization (also called dinamization): The combined process of serial dilution and succussion or trituration at each step in the manufacture of homeopathic medicines from stocks. (According to the tenet of homeopathy, potentization represents the process by which the activity of a homeopathic medicine is developed.)

The potentisation steps in a potency row can be performed in different dilution ratios:

D or X: 1:10

C or CH: 1:100

LM 1:50,000.

So, for example, D4 means potentised four times in the ratio 1:10. The higher the number of potency the lower the concentration.

1.3.2 Preparation and Standardization of Ayurvedic Formulations

1.3.2.1 Bhasma

Bhasma is a calcinated preparation in which the gem or metal is converted into ash. *Example- Suvarnabhasma, Pravalbhasma, Lauhbhasma, Shankhbhasma.* Bhasmikaran is a process by which a substance which is otherwise bioincompatible is made biocompatible by certain samskaras or processes. The objectives of samskara are elimination of harmful matters from the drug, modification of undesirable physical properties of the drug, conversion of some of the characteristics of the drug and enhancement of the therapeutic action. Various steps involved in the preparation of bhasma(or bhasmikaran) are: 1. Sho-dhan- Purification, 2. Maran - Powdering, 3. Chalan- Stirring, 4. Dhavan - Washing, 5. Galan- Filtering, 6. Putan- Heating, 7. Mardan- Triturating, 8. Bhavan- Coating with herbal extract, 9. Amrutikaran - Detoxification and 10. Sandharan - Preservation.

Selection of these steps depends on the specific metal. Sometimes there is an overlapping of the steps Example- maran is achieved by puttan. The bhasmas' used in Ayurveda for treatment of various diseases for the past several centuries is the oldest form of nano-technology. Nano particles are 1 crore times smaller than a hair and due to its small size, the basic characteristics also get changed. Due to change in electrical, thermal, magnetic, optical, chemical and biological characteri-stics, the particles can be used for various products.

Steps involved in the preparation of bhasma (or bhasmikaran) are:

- ✓ Shodhan –Purification
- ✓ Maran - Powdering
- ✓ Chalan- Stirring
- ✓ Dhavan - Washing
- ✓ Galan- Filtering
- ✓ Putan- Heating
- ✓ Mardan- Triturating
- ✓ Bhavan- Coating with herbal extract
- ✓ Amrutikaran - Detoxification and
- ✓ Sandharan- Preservation
- ✓ specified metal, mineral, and animal product (*Kasaya*)
- ✓ cakes are made (*Cakrikas*) and dried under the sunlight
- ✓ mud tray and closed with another tray and the clay smeared with cloth of seven consecutive layers
- ✓ Dig a pit of appropriate size. Half of the pit is filled with dried cow dung cakes
- ✓ Put tray. Pack with the cow dung cake. Fire is lit from all sides and in the middle of the pit
- ✓ Cool at room temperature. Remove tray, break seal, podwer the chakrikas.

Preparation

1. ***Shodhana:*** In *Ayurveda* the very first stage of metal purification is called *Shodhana* to eliminates harmful matter, modifies or converts undesirable properties to desirable enhanced therapeutic actions. Shodhana is of two types, *Samanya shodhana* and *Vishesh shodhana*. In *Samanya Shodhana,* the sheets of metals are heated till red hot and are successively dipped into liquids like oil, buttermilk, cow's urine etc. The procedure is repeated seven times. In *Vishesh Shodhana* For some metals a specific process is described for shodhan Example- for purification of Jasad, the molten mass is poured in cow's milk 21 times.
2. ***Marana:*** Maran literally means killing where metal lose its metallic characteristics and physical nature. Here the purified drug is grounded with the specified metal, mineral and animal product (*Kasaya*) for a specified period of time to from small cakes (*Cakrikas*) which are further dried under the sunlight. The dried cakes are placed in a single layer in a mud tray and closed with another tray and the clay smeared with cloth of seven consecutive layers. This tray is then placed into the half filled pit with dried cow dung cakes and the pit is again packed with the cow dung cake. Fire is lit from all sides and in the middle of the pit. After specified burning, it is allowed to cool at room temperature. The clay tray is removed, and the seal is broken. The contents are taken out and finely powdered.
3. ***Chalan:*** Process of stirring with iron rod or plant stick during heating the metal is known as chalan. Iron serves as catalyst and the phytoconstituents of plant stick may be enhancing the therapeutic effect. For example, stick of Neem is used for chalan process of Jasad bhasma, which is used topically for ophthalmic diseases.
4. **Dhavan**: This means several time washing of product with water to remove the excess amounts of agents used in shodhan or maran stage.
5. **Galan:** It means sifting of the product either through a fine cloth or through sieves of suitable mesh so as to separate residual material larger in size.
6. **Puttan:** The term puttan means ignition. This is key process in manufacturing the bhasma which involves heating the product in a special shallow earthen pot called as Sharav in a faster and uniform format. The classification of putta is primarily done on the basic nature of the process and is as under: 1. Chandra-putta 2. Dhanyarashiputta 3. Surya-putta 4. Bhugarbhaputta 5. Agniptuta.

Characteristics: The final Bhasma should be free from metallic luster. Bhasma when rubbed between fingers should be so fine so as to get easily into the lines or crevices of finger. In water Bhasma should float on the surface.

1.3.2.2 Asava and Arishta

Asava and *arishtas* are the self generated fermented alcoholic liquid preparations. Fermentation is brought about by the addition of *dhataki* (*Woodfordia fruticosa*) flowers. Fermented alcohol facilitates the extraction of active constituents in the drug and also acts as a preservative. Both *Asava* and *arishtas* contain up to 12% of alcohol and hence are also called medicinal wines. *Arishtas* are prepared with decoctions of herbs in boiling water while *asavas* are prepared by direct use of fresh herbal juices.

Aristha Preapartion	Asava Preapartion
Clean, dry and powder the crude drug and prepare the decoction in potable water. The wooden pots should be fumigated with pimply *churna* and also smeared with ghee before addition of parent material or sugar.	Boil the required quantity of potable water; add sugar, *jaggery* or honey, cool and transferr to the wooden vessel.previously fumigated with pimply *churna* and also smeared with ghee
Then add pure sugar (cane sugar), honey or jaggery (very old), according to the preparation, to the decoction.	Then, add finely powdered drug mentioned in the formula.
Now add *dravas*, other powder ingredients and *dhatakipushpa,* if mentioned.	Now add *dravas*, other powder ingredients and *dhatakipushpa,* if mentioned.
Place the vessels in the basement (underground cellar) all under a heap of paddy to ensure constant atmospheric temperature during the whole process of fermentation. After the specified period, generally from 7-10 days, remove the pot and decant the fluid. After 2-3 days when the fine particle of sediment is settled down, the arishta is bottled.	Place the vessels in the basement (underground cellar) all under a heap of paddy to ensure constant atmospheric temperature during the whole process of fermentation. After the specified period, generally from 7-10 days, remove the pot and decant the fluid. After 2-3 days when the fine particle of sediment is settled down, the Asava is bottled.

Arishta Preparation: Clean, dry and powder the crude drug and prepare the decoction in potable water. Filter and the prepared decoction and transfer to the wooden pots. The wooden pots should be fumigated with pimply *churna* and also smeared with ghee before addition of parent material or sugar. Then add pure sugar (cane sugar), honey or jaggery (very old), according to the preparation, to the decoction. Now add *dravas*, other powder ingredients and *dhatakipushpa,* if mentioned. Close the vessel with the lid and seal the edges with the clay smeared cloth of seven consecutive layers. Place the vessels in the basement (underground cellar) all under a heap of paddy to ensure constant atmospheric temperature during the whole process of fermentation. After the specified period, generally from 7-10 days, remove the pot and decant the fluid. After 2-3 days when the fine particle of sediment is settled down, the arishta is bottled. **Example:** *Ashokarishta, Dharakshrishta, Dashmularishta*. Arishta can be stored for any length of time in a well stoppered glass bottle.

Characteristics: The filtered final arishta should not contain any particle of sediment. The taste should not be sour. The preparation should have the characteristic odour of fermented liquid. If any growth of mould is observed, reject immediately. Mix equal quantity of water and aristha before consumption.

Asava Preparation: For the preparation of *asava*, boil the required quantity of potable water; add sugar, *jaggery* or honey, cool and transferr to the wooden vessel. Then, add finely powdered drug mentioned in the formula. Cover the container with a lid and the edges are sealed with seven consecutive layers of clay smeared cloth. The vessel is kept in the basement for the specified period of time, after which the pot is removed and the liquid is decanted or filtered. **Example:** *Kumariasava, Chonclanasavo, Lauhasava. Asava* can be stored for any length of time in a well stoppered glass bottle.

Characteristics: The filtered final Asava should not contain any particle of sediment. The taste should not be sour. The preparation should have the characteristic odour of fermented liquid. If any growth of mould is observed, reject immediately. Mix equal quantity of water and Asava before consumption.

Table 1.4 Examples of few Asavas and Aristhas

Name	Uses
Abhayarishta	Carminative and appetizer. Indicated in piles, anemia, colitis, cardiac, lesions, spleen and other intestinal disorders, Also removes constipation.
Arjunaristha	Tonic and cardiac stimulant. used in diseases of heart and respiratory disorders.
Ashokarishta	Alterative, stimulant and astringent. Used in leucorrhoea, haematuria, menorrhagia and other female complaints
Balarishta	Antirheumatic and diuretic. Indicated in hemiplegia, rheumatic pains.
Chandanasava	Diuretic and urinary antiseptic .Used in gonorrhoea, spermatorrhoea and other urinary diseases.
Dashmoolarishta	Bitter tonic,Alterative and stimulant, Useful in cough, menonervous diseases, consumption, anemia, jaundice, piles and as a parental tonic.
Drakshava	Stimulant antipyretic, diuretic, it is invigorating and nourishing. Used in phthisis, insomnia, loss of appetite, cough, general debility and premature sanity.
Kalmeghasava	Expectorant, Laxative, stimulant. Used in chronic respiratory disorder, flatulence and other disease of alimentary system.
Kumariasava	Alterative tonic and haematinic. Used in anemia, enlargement of the liver, endocrinal, deficiency, tympanites, cough, asthma and constipation.
Kutajarishta	Astringent, stimulant, and antiperiodic. Used in dysentery, diarrhea, fever and sprue.
Punarnavarishta	Diuretic, alterative and haematinic Indicated in beriberi, Edema, abdominal disorders and liver complains
Vidangasava	Carminative, anthelmintic. Used in paralysis, Paraplegia, lock jaw and in destroying worms.

1.3.2.3 Leha (Avaleha/Paka)

Leha also called as *avalehaor paka*, is a semisolid Ayurvedic preparation consisting of *kasayas*, or powder drugs alongwith*jaggery*, sugar or Khanda-sari and ghee or oil or liquid. Example- *Vasavaleha, Dhrakshavaleha, Musalipaka, Suvarnleha*.

Preparation: Dissolve *jaggery*, sugar or sugar-candy in the liquid and strain to remove the foreign particles. Boil this solution over a moderate fire. When *paka* becomes thready (*Tantuvat*), or when it sinks in water without getting easily dissolved, it should be removed from the fire. Then add fine powders of drugs with continuous stirring to form a homogenous mixture. Add ghee or oil, if mentioned while the preparation is hot and mix well. Add Honey, if mentioned when the preparation becomes cool and mix well until the *paka* is obtained.

Characteristicsp: *Leha* should neither be hard nor be a thick fluid. *Leha* should roll between the fingers. *Leha* should be kept in glass and porcelain jars. Normally *leha* should be used within 1 year.

1.3.2.4 Churna

Churna is a solid Ayurvedic preparation of fine powder of the drug/s which is often taken with some *anupan* such as milk, ghee or honey. Finer the powder the better it's therapeutic effect.

Preparation : Clean, dry, powder and sieve through cloth, the drugs mentioned in the formula. This can be also done by a disintegrator or mechanical sifter. When there is more than one drug, each drug should be separately powdered, sieved and weighed. As some of the drugs contain more fibrous material than the others, it should be treated by a special process as mentioned in the formula. Finally, mix all the powders well together. If salt, sugar, camphor is mentioned, then it should be powdered and added separately at the end.

Characteristics: Powder should be fine at least of 80 mesh size. It should be kept in an air tight container. It should be used within 6 months.

1.3.2.5 Gutika/Vati

This is a solid Ayurvedic formulation in the form of small tablets of drugs of plant, animal or mineral origin. Example- *Astaksarigutika, agnitundivati*

Preparation: Dry and powder the mentioned drugs separately. Reduce the mineral to bhasma or sindura unless otherwise mentioned. If required, prepare *kajjali* of some drugs. The processed *kajjali* is put in *kalba* and ground to a soft paste with the prescribed liquid. When more than one fluid is mentioned, use them in succession while grinding. When the mass does not stick to the fingers then mold into the *vati*, add sugandhadravas like *kasturi*, *kapoor* with continuous grinding. Now roll the pills and dry under sun or shed. Pills should be kept in an air tight container.

Characteristics: It should not lose its original taste, colour, smell and form. It should be used within 24 months in case of plants and indefinite period for minerals.

Shelf life of Ayurvedic drugs

Sr.No	Dosage form	Shelf life or date of expiry with effect from the date of manufacture
(i)	Anjana	
	a) Anjana made from Kasthaushadhi	1 year
	b) Anjana made from Kasthaushadhi along withRasa/Uprasa/ Bhasma	2 years
	c) Anjana made only from rasa/Uprasa/Bhasma	3 years
(ii)	Arka	1 year
(iii)	Asava Arista	10 years
(iv)	Avaleha, Khanda, Paka, Guda	3 years
(v)	Chuma, KwathaChuma, LepaChuma, DantaManjan, (Chuma)	2 years
(vi)	Dhoopan	2 years
(vii)	Dravaka, Lavana, Kshara	5 years
(viii)	Ghrita	2 years
(ix)	Guggulu	5 years
(x)	Gutika/Vati	
	(i) Gutika or Vati containing Kasthaushadhi along withRasa / Uprasa/ Bhasma/ Guggulu (including LepaGutikaand GhanVati)	5 years
	(ii) Gutika or Vati containing only Kasthaushadhi (including LepaGutika and GhanVati)	3 years

Contd…

Sr.No	Dosage form	Shelf life or date of expiry with effect from the date of manufacture
	(iii) Gutika / Vati containing only Ras / Uprasa / Bhasmaexcept Naga, Vanga and TamraBhasma	10 years
(xi)	Kama/ Nasabindu	2 years
(xii)	KupipakvaRasayana	10 years
(xiii)	Malahar	3 years
(xiv)	Mandura-Lauha	10 years
(xv)	Naga Bhasma, Vanga Bhasma and TamraBhasma	5 years
(xvi)	Netrabindu	1 years
(xvii)	Parpati	10 years
(xviii)	Pishti and Bhasma except Naga, Vanga and TamraBhasma	10 years
(xix)	PravahiKwatha	3 years
(xx)	Rasayoga	
	(i) Rasayoga Containing only Rasa / Uprasa / Bhasma except Naga, Vanga and TamraBhasma	10 years
	(ii) Rasayoga Containing Rasa / Uprasa/ Bhasma along with Kasthaushadhi/Guggulu	5 years
(xxi)	Sattva (derived from medicinal plant)	2 years
(xxii)	Sharkar / Panak/Sharbat	3 years
(xxiii)	Shvetaparpati	2 years
(xxiv)	Taila	3 years
(xxv)	Varti	2 years

Subjective Questions

1. How to authetify herbal materials?
2. How to process herbal raw material?
3. What is biodynamic agriculture?
4. What is biopesticide?
5. How to manage pest in medicinal plant?
6. What are basic principles involved in Ayurveda or Sidhha or Chinese medicine system?
7. How to prepare and evaluate Ghutika or Bhasma or Lehya
8. What is difference between Asava and Aristha?
9. How agriculture and cultural or mechanical and Physical methods of pest control are replted?
10. What is IPM?
11. What are plant pesticides?
12. What are different mills used to pulverize crude drugs? Give example based on type of crude drugs?

13. Give suitable examples of different storage containers used for crude drugs.
14. What is shelf life of Leha and Bhasma?
15. What is shelf life of Gutika and taila?

Multiple Choice Questions (MCQs)/Objective Questions

1. According to WHO, the terminology used to represent crude plant materials such as leaves, flowers, fruits, seed, stem, wood, bark, rhizome or other plant parts which may be entire or fragmented or powdered is called as
   a. Shrub
   b. Herb
   c. Tree
   d. All of the above
2. The study or practice of the medicinal or therapeutic use of plants especially as a form of alternative medicine is known as ……
   a. Herbalism
   b. Herbal medicine
   c. Paraherbalism
   d. Both a and b
3. Alternative and pseudoscientific practices of using unrefined plant or animal extracts as unproven medicines called as …….
   a. Herbalism
   b. Herbal medicine
   c. Paraherbalism
   d. Both a and b
4. Any medicinal product exclusively containing one or more herbal substances as active ingredients/ one or more herbal preparations or a combination of two is known as ……
   a. Herbal medicine
   b. Herbal product
   c. Dietary food
   d. Herbal drug
5. Which one of the following formulation is NOT herbal drug preparation?
   a. Tincture
   b. Infusion
   c. Extract
   d. Talc
6. Which one of the following serves as intermediate in the process of producing finished herbal products or herbal dosage forms for therapeutic use ……..
   a. Herbal medicine
   b. Herbal preparation
   c. Herbal material
   d. Both a and b
7. The word herb is derived from …….word “Herba”
   a. Italian
   b. Spanish
   c. Latin
   d. Greek
8. Sources of herbs are ……..
   a. Animals
   b. Insects
   c. Marine
   d. Plants

9. Quality, safety and efficacy of a herbal drug material depends on largely …….
   a. Correct identification of herb
   b. Authentication of herb
   c. Cultivation technique
   d. Both a and b

10. The process of quality assurance that ensures the correct plant species and plant parts used as raw materials for herbal medicines is called as ……
   a. Identification
   b. Authentication
   c. Quality control
   d. None

11. Which one of the following is NOT quantitative microscopy?
   a. Lycopodium spore method for percentage purity
   b. Pallisade ratio
   c. Stomata index
   d. None

12. According to WHO, Upper limit for number of *E.coli* per gram of crude drug material is …
   a. 10
   b. 10^4
   c. 10^2
   d. 9

13. Aflatoxin contamination is determined by ……
   a. TLC using standard Aflatoxins (B_1,B_2,G_1,G_2) mixture
   b. HPLC using standard Aflatoxins (B_1,B_2,G_1,G_2) mixture
   c. Microbial plate culture
   d. None of the above

14. Which one of the following methodin primary processing is used for enzymatic degradation of toxic ingredients of crude herbal materials?
   a. Sweating
   b. Aging
   c. Heating
   d. Drying

15. For which drug, aging technique is utilized for neutralization of toxic ingredients before utilization as herbal medicine?
   a. Rhubarb
   b. Cascara
   c. Datura
   d. None

16. Primary processing is an important step in herbal drug processing because of ……
   a. Increases secondary metabolite levels of drug
   b. Enhances cost effectiveness
   c. Neutralizes toxic ingredients and reduces side effects of drug
   d. All of the above

17. The process in which herbal drug material is kept in boiling water for short period of time without being fully cooked to increase storage life of crude drug is known as …..
    a. Sweating
    b. Aging
    c. Blanching
    d. Steaming
18. Before decoction or infusion, which primary process is implemented commonly?
    a. Blanching
    b. Steaming
    c. Stir frying
    d. Bleaching
19. In which method, boiling water is poured over the herb or herbal material to produce a dilute liquid preparation?
    a. Decoction
    b. Infusion
    c. Maceration
    d. Percolation
20. Tincture is typically made up of …..
    a. 1 part herbal material and 5-10 parts of solvent
    b. 2 parts of herbal material and 5-10 parts of solvent
    c. 3 parts of herbal material and 5-10 parts of solvent
    d. 4 parts of herbal material and 5-10 parts of solvent
21. Which one of the following is responsible for water holding capacity of soil?
    a. Clay
    b. Fine soil particles
    c. Humus
    d. Tree plantation
22. In organic farming, which two factors plays very important role for the desired growth of plants?
    a. Rain fall
    b. Organic matter
    c. Water holding capacity of soil
    d. Both b and c
23. Which one of the following micro organisms is NOT responsible for nitrogen fixation?
    a. E.coli
    b. Azospirillium
    c. Azolla
    d. Bijericcia
24. The quality, safety and efficacy of a medicinal herb highly depends on……
    a. Cultivation technique
    b. Collection technique
    c. Appropriate harvesting
    d. All of the above
25. Phytopthora root rot disease in belladonna occurs due to microorganism……
    a. Ascochyta atropae.
    b. Cercospora atropae.
    c. Phytopthoranicotianae
    d. Phytopthoraerythrosceptica
26. Leaf necrosis in medicinal plants is caused by……
    a. Cercospora atropae
    b. Ascochyta atropae
    c. Pythium spinosum
    d. One

27. Cucumber mosaic virus is observed on which Medicinal plants?
    a. Digitalis.
    b. Hyoscyamus.
    c. Datura
    d. Both a and b
28. All insect pests belongs to phylum …….
    a. Anthropoda
    b. Vertebrate
    c. Invertebrate
    d. None
29. Which weed is responsible for allergic response hay fever?
    a. Parathenium.
    b. Mexican tea.
    c. Yellow dock
    d. All
30. Which one of the following weed belongs to poisonous category?
    a. Menispermus species.
    b. Datura.
    c. Both a and b
    d. None
31. Which one of the following is NOT invertebrate pest?
    a. Crabs
    b. Snails
    c. Rats
    d. Mites
32. Which one of the following is not mechanical method of pest control?
    a. Hand picking
    b. Pruning
    c. Burning
    d. pesticides
33. Sex pheromone 7,8 – epoxy – 2 methyloctadecane, a biological pest control is obtained from……
    a. Screw worms
    b. Lady bug
    c. Gypsy moth
    d. None of the above
34. Which one of the secondary metabolite acts as rodenticide?
    a. Strychnine
    b. Quinine
    c. Atropine
    d. Warfarin
35. Which one of the following is NOT Herbicide?
    a. 2,4 – dichlorophenoxy acetic acid
    b. Calcium arsenate
    c. Sulphuric acid
    d. DDT
36. Organophosphorous compounds and carbamates exert pesticidal activity on animals by…
    a. Neurotoxication
    b. Inhibition of neuromuscular junction
    c. Inhibition of acetyl cholinesterase
    d. None
37. On which date, Bioincecticides were registered under insecticides Act 1968 by Central Insecticide Board, Ministry of Agriculture, New Delhi?
    a. 26/03/1995
    b. 26/03/1996
    c. 26/06/1998
    d. 26/06/1999

38. *Agrobacterium tumefaceins* was registered as biopesticide under insecticide act 1968 in
    a. 2002
    b. 2003
    c. 2004
    d. 2005
39. Carbamates acts as weedicide by ……..
    a. Inhibition of pentothenate synthesis
    b. Inhibition of oxidative phosphorylation
    c. Inhibition of chlorophyll synthesis
    d. None
40. The insecticidal principles in pyrethrum are located in which part of pyrethrum plant?
    a. In oleoresin secretion of leaves
    b. In oleoresin secretion of floral parts
    c. In oleoresin secretion of stem
    d. None
41. Asava is prepared by ……
    a. Soaking drug in water before decoction
    b. Drug is coarsely powdered and added to water
    c. Both a and b
    d. None of the above
42. In Arishta preparation, the ratio of crude drug to water is generally ……
    a. 1:4
    b. 1:16
    c. Both a and b
    d. None
43. In Arishta preparation, sugar is jaggery is added to……..
    a. Concentrated decoction as last part of process
    b. Dilute solution of coarse powdered drug
    c. Before decoction of crude drug
    d. None
44. Amongst Asava and Arishta, which preparation contains high amount of water?
    a. Asava
    b. Arishta
    c. Both a and b
    d. None
45. Which method is used for standardization of Asava and Arishta preparation?
    a. Water content determination
    b. Microbial content determination
    c. Alcohol content determination
    d. Both a and b

46. Which one of the following ingredient is used as binding agent in Gutika preparation?
    a. Jaggery
    b. Sugar
    c. corn floor
    d. gum
47. Which parameters are investigated for standardization of Gutika preparation?
    a. Disintegration time
    b. Solubility
    c. Dissolution time
    d. Both a and c
48. Which one of the ingredient is used as flavouring agent as well as carminative in Gutika?
    a. Coriander
    b. Dill
    c. caraway
    d. Fennel
49. Churna is Ayurvedic formulation prepared from…….
    a. Fresh herbs in powdered form
    b. Dried herbs in powdered form
    c. Both a and b
    d. None
50. Which excipients are used in Churna preparation?
    a. Jaggery
    b. Sugar
    c. fennel
    d. None of the above
51. Which phytochemical parameters are investigated during standardization of Churna preparation?
    a. Ash value
    b. Foreign particle determination
    c. Moisture content determination
    d. All of the above
52. Which parameter is critical for shelf life of Churna preparation?
    a. Ash value
    b. Moisture content
    c. Solubility
    d. Both a and b
53. Lehya is …….Ayurvedic dosage form
    a. Solid
    b. Liquid
    c. Semi-solid
    d. Powdered
54. Which ingredients are used for preparation of Lehya?
    a. Kashaya or churna
    b. Madhu
    c. Ghrita
    d. All of the above
55. What is the role of Ghrita in Lehya preparation?
    a. Laxative
    b. Lipophillic agent
    c. Hydrophobic agent
    d. Preservative

56. Which parameter is used for standardization of lehya preparation?
    a. Ash value
    b. Saponification value
    c. Moisture content
    d. All of the above

57. In Bhasma preparation, the step in which purified metals are amalgamated with mercury and purified sulphur to form black, lusterless, fine smooth mass is called as
    a. Bhavana
    b. Kupipaka
    c. Kajjali
    d. Marana

58. The presence of luster in finally prepared bhasma indicates …….
    a. Incomplete Shodhana process
    b. Incomplete Marana Process
    c. Incomplete bhavana process
    d. None

59. The particle size of swarnabhasma is generally…….
    a. 100 – 120 nm
    b. 56 – 57 nm
    c. 200 – 250 nm
    d. 150 – 200 nm

60. Which step in bhasma preparation removes toxicity of metals?
    a. Shodhana
    b. Marana
    c. Bhavana
    d. All

Answer Key

1. b	2. d	3. c	4. b	5. d	6. b	7. c	8. d	9. d	10.b
11. d	12. b	13. a	14. b	15. b	16. d	17. c	18. a	19. b	20. a
21. c	22. d	23.a	24. d	25. d	26. a	27. d	28. a	29. c	30. c
31. d	32. d	33. c	34. a	35. c	36. c	37. d	38. c	39. c	40. b
41. b	42. c	43. a	44. a	45. c	46. a	47. d	48. d	49. b	50. c
51. d	52. b	53. c	54. d	55. b	56. b	57. c	58. a	59. b	60. b