

**CULTIVATION, COLLECTION,
PROCESSING AND STORAGE OF
DRUGS OF NATURAL ORIGIN**

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Cultivation of Crude Drugs:

Cultivation of medicinal plants requires intensive care and management.

The conditions and duration of cultivation required vary depending on the quality of medicinal plant materials required.

Methods of Propagation:

I. Vegetative propagation (Asexual propagation):

Vegetative propagation can be defined as regeneration or formation of a new individual from any vegetative part of the plant body. The method of vegetative propagation involves separation of a part of plant body, which develops into a new plant.



S.NO	VEGETATIVE PLANT PART	EXAMPLE
1.	Bulb	Allium
2	Tuber	Potato.
3	Offset	Valerian.
4	Rhizome	Ginger and Haldi.
5	Vegetative propagation by root	Asparagus
6	Corms	Colchicum.
7	Runner	Peppermint.



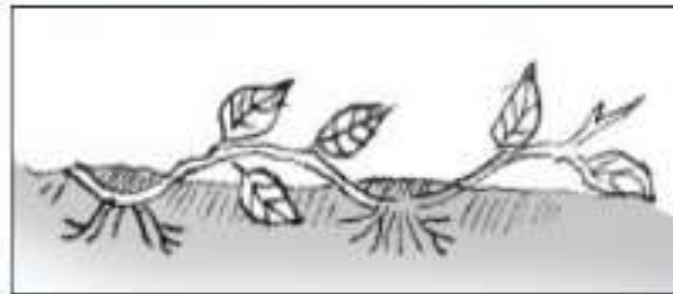
Other Vegetative propagation methods

1. Cutting:

These are the parts of the plant (stem, root or leaf) which, if grown under suitable' conditions, develop new plants. Stem cutting are generally used to obtained new plants. *Examples:* Sugarcane and rose, etc.

2. Layering:

Roots are induced on the stem while it is still attached to the parent plant. This part of stem is later detached from the parent plant and grown into a new plant. *Examples:* Jasmine plant



3. Grafting:

New variety is produced by joining parts of two different plants. The rooted shoot of one plant, called stock, is joined with a piece of shoot of another plant known as scion.

Examples: Rose, citrus and rubber, etc.

Advantages of Asexual Propagation

- As resultant species formed through asexual process are genetically identical, useful traits can be preserved among them.
- Asexual propagation allows propagation of crops that do not possess seeds or those which are not possible to grow from seeds. For e.g. Jasmine, sugarcane, potato, banana, rose etc.Plants grown through vegetative propagation bear fruits early.
- In this type, only a single parent is required and thus it eliminates the need for propagation mechanisms such as pollination, cross pollination etc.
- The process is faster than sexual propagation. This helps in rapid generation of crops which in turn balances the loss.

Disadvantages of Asexual Propagation

- Diversity is lost in asexual propagation which is the main reason behind occurrence of diseases in future plant species.
- As many crops are produced with this process, it leads to overcrowding & lack of nutrients.
- New varieties of crops cannot be developed in this type of propagation.
- Asexual propagation is an expensive process that requires special skills for successful cultivation of crops.
- Crops produced through this process have shorter life-span than those grown through sexual process.
- Species involved in this process are less likely to resist pests and diseases.

Importance of Asexual propagation

1. It is a cheaper, easier and rapid method of multiplication. Many fruit trees usually require 4-5 years to bear the fruits when developed from seeds. The plants developed by vegetative methods, take only a year to bear fruits.
2. Plants like roses and chrysanthemum, etc do not form viable seeds. Thus, vegetative propagation is the only method of propagation is the only method of reproduction and continuation of species in such plants.
3. All the plants developed by these methods will be generally similar to the parent plant.

II. Sexual Propagation The process of sexual propagation:

(i) Pollination: This is the transfer of pollen grains from the anther to the stigma.

(ii) Fertilization: Fusion of male and female gametes takes place, resulting in the formation of zygote

(iii)Seedling: Multiplication of plants by using seed is called as seed propagation

Dormancy: It is term used to describe a seed that will not germinate because of any condition associated either with the seed itself or with existing environmental factors such as temperature and moisture.

Rest Period: Some seeds will not germinate immediately after harvest even if conditions are favorable. This failure to germinate is due to physiological condition. This is said to be the seeds are in the rest period.

Seed viability and longevity: Viability means the presence of life in the seed. Longevity refers to the length of time that seeds will retain their viability. Some seeds are short lived. (Citrus).

Pre – germination Seed Treatments to improve germination rate

1. Chemical (Acid scarification)

The purpose is to modify hard or important or impermeable seed covering generally soaking seed in concentrated sulphuric acid is an effective method.

The time of treatment may vary from 10 minutes to 6 hour according to species sometimes phyto hormones like gibberellins, ethylene, Cytokinins are also used.

Other chemicals like Potassium nitrate, Thiourea, Sodium hypochlorite also used.

2. Mechanical (Scarification): Seeds of a few species with impermeable seed coat. i.e. hard seed coat can be rendered permeable to water and gases their germination is greatly improved by mechanical scarification in taking care that seeds should be injured *not be injured heavily.

This can be achieved by

- i) Placing the seeds between two sand paper doses, one station and other revolving.
- ii) Passing seeds through machine that scratches the surface.
- iii) Filing and notching to make the seed coat permeable to water.

3. Seedling (Boiled Water Treatment): Pouring boiling water over seeds and getting it to cool gradually for about 12 hour to soften hard shelled seeds.E.g. *Coffee*.

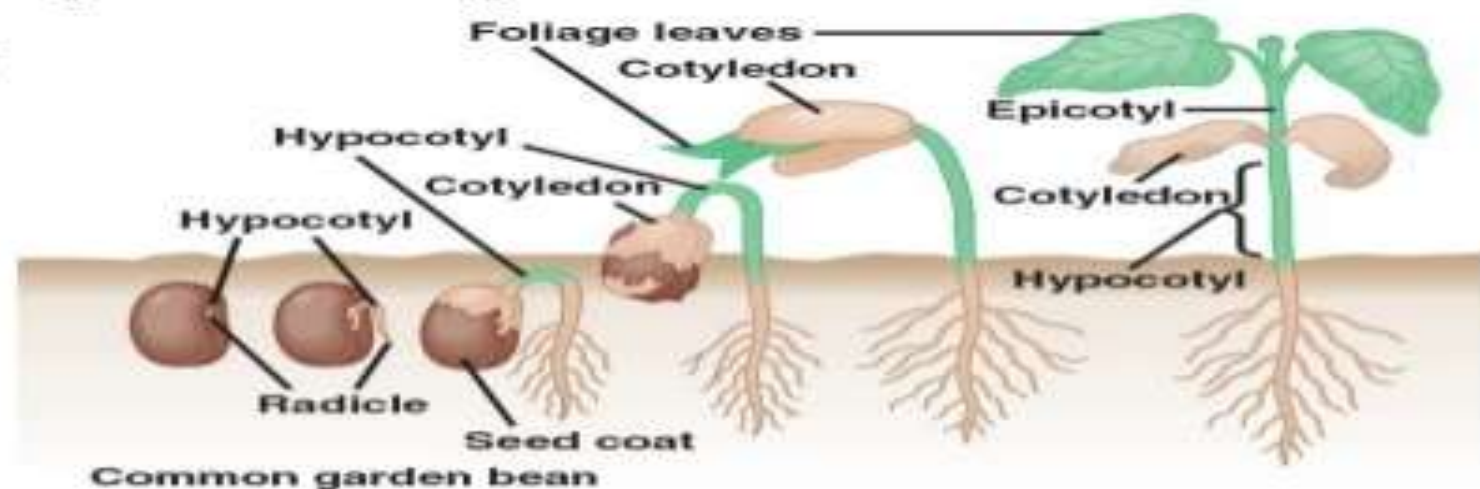
4. Soaking in Water: The purpose of soaking seeds in water is to modify hard seed coats, to remove inhibitors to soften seed and to reduce the time of germination.

The time of soaking seeds in cold water depend upon the hardness of the seed coat.
E.g *beans*.

5.Moist Chilling: Seed of many woody trees or shrubs are exposed to low temperature to bring about prompt and uniform germination.

Germination rate measured by

1. Rolled towel test
2. Excised embryo test



Advantages of Sexual Propagation

- Simplest, easiest and the most economical process
- Some plants, trees, vegetables or fruits species can propagate only through sexual propagation. E.g. – marigold, papaya, tomato.
- This type of propagation leads to better crop species that are stronger, disease-resistant and have longer life-span.
- Viral transmission can be prevented in this type of propagation.
- It is the only propagation process in which resultant offspring have genetic variation and exhibit diversity of characters from parent crops.
- This genetic variation is responsible for continuous evolution that keeps on producing better & better offspring.
- Easy storage and transportation of seeds.

Disadvantages of Sexual Propagation

- Seeds take a long time to turn into mature plants i.e. time interval between sowing and flowering is longer.
- Seedlings propagated through sexual propagation are unlikely to have same genetic characteristics as that of parent plants
- Some plant species do not produce viable seeds through sexual propagation and hence are unsuitable to propagate for the same.
- Plants that do not have seeds can't be propagated through this process.
- There are many factors that can affect the viability of seeds, including moisture, air, temperature, and light.

III. Micro propagation / Plant Tissue Culture

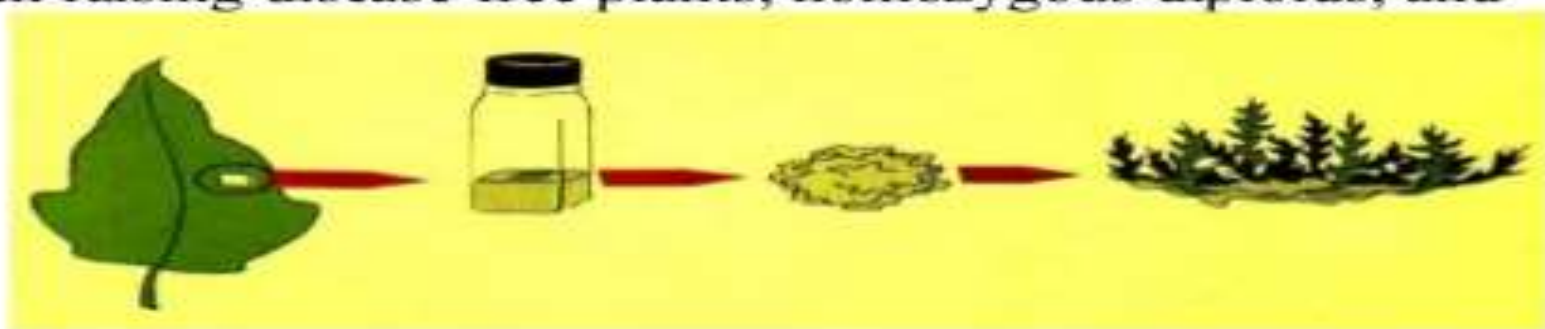
This method consists of growing cell, tissue and organ in culture. Small pieces of plant organs or tissues are grown in a container with suitable nutrient medium, under sterilized conditions.

The tissue grows into a mass of undifferentiated cells called callus which later differentiates into plantlets.

These are then transferred into pots or nursery beds and allowed to grow into full plants.

Plant tissue culture is widely used to produce clones of a plant in a method known as micropropagation to conserve rare or endangered plant species.

Micro propagation is useful in raising disease free plants, homozygous diploids, and those without viable seeds.



COLLECTION OF DRUGS

- Medicinal plant materials should be collected during the appropriate season or time period to ensure the best possible quality of both source materials and finished products.
- It is well known that the quantitative concentration of biologically active constituents varies with the stage of plant growth and development.
- The best time for collection (quality peak season or 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.
- In general, the collected raw medicinal plant materials should not come into direct contact with the soil. If underground parts (such as the roots) are used, any adhering soil should be removed from the plants as soon as they are collected.
- Collected material should be placed in clean baskets, mesh bags, other well aerated containers.

- After collection, the raw medicinal plant materials may be subjected to appropriate preliminary processing, including elimination of undesirable materials and contaminants, washing (to remove excess soil), sorting and cutting.
- The collected medicinal plant materials should be protected from insects, rodents, birds and other pests, and from livestock and domestic animals.
- If the collection site is located some distance from processing facilities, it may be necessary to air or sun-dry the raw medicinal plant materials prior to transport.
- If more than one medicinal plant part is to be collected, the different plant species or plant materials should be gathered separately and transported in separate containers. Cross-contamination should be avoided at all times.
- Collecting implements, such as machetes, shears, saws and mechanical tools, should be kept clean and maintained in proper condition.
- Those parts that come into direct contact with the collected medicinal plant materials should be free from excess oil and other contamination.

HARVESTING

- Medicinal plants should be harvested during the optimal season or time period to ensure the production of medicinal plant materials and finished herbal products of the best possible quality.
- Care should be taken to ensure that no foreign matter, weeds or toxic plants are mixed with the harvested medicinal plant materials.
- Medicinal plants should be harvested under the best possible conditions, avoiding dew, rain or exceptionally high humidity.
- If harvesting occurs in wet conditions, the harvested material should be transported immediately to an indoor drying facility so as to prevent any possible deleterious effects due to increased moisture levels, which promote microbial fermentation.
- Cutting devices, harvesters, and other machines should be kept clean and adjusted to reduce damage and contamination from soil and other materials.

- 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.
- The harvested raw medicinal plant materials should be transported promptly in clean, dry conditions they may be placed in clean baskets, dry sacks, trailers, hoppers or other well-aerated containers and carried to a central point for transport to the processing facility.
- All containers used at harvest should be kept clean and free from contamination by previously harvested medicinal plants and other foreign matter.
- When containers are not in use, they should be kept in dry conditions, in an area that is protected from insects, rodents, birds and other pests, and domestic animals.
- Decomposed medicinal plant materials should be identified and discarded during harvest, post-harvest inspections and processing, in order to avoid microbial contamination and loss of product quality.

The following general rules for collection of crude drugs:

Roots and rhizomes are collected at the end of the vegetation period, i.e. usually in the autumn. In most cases they must be washed free of adhering soil and sand.

Bark is collected in the spring.

Leaves and herbs are collected at the flowering stage.

Flowers are usually gathered when fully developed.

Fruits and seeds are collected when fully ripe.

Methods of collection

- Medicinal plants must be largely collected by hand.
- With cultivation on a large scale, it may be possible to use modern agricultural harvesters, but in many cases, e.g. barks, manual collection is unavoidable. Thus, the cost of drug production is largely the cost of the labor involved.

As per WHO Guidelines

1. Medicinal plants/herbal drugs should be harvested when they are at the best possible quality for the proposed use.
2. Damaged plants or parts plants need to be excluded.
3. Medicinal plants/herbal drugs should be harvested under the best possible conditions avoiding wet soil, dew, rain or exceptionally high air humidity. If harvesting occurs in wet conditions possible adverse effects on the medicinal plant/herbal drug due to increased moisture levels should be counteracted.
4. Cutting devices or harvesters must be adjusted such that contamination from soil particles is reduced to a minimum.
5. The harvested medicinal plant/herbal drug should not come into direct contact with the soil. It must be promptly collected and transported in dry, clean conditions.

6. During harvesting, care should be taken to ensure that no toxic weeds mix with harvested medicinal plants/herbal drugs.
7. All containers used during harvesting must be clean and free of contamination from previous harvests. When containers are not in use, they must be kept in dry conditions free of pests and inaccessible to mice/rodents, livestock and domestic animals.
8. Mechanical damage and compacting of the harvested medicinal plant/herbal drug that would result in undesirable quality changes must be avoided.
9. Freshly harvested medicinal plants/herbal drugs must be delivered as quickly as possible to the processing facility in order to prevent thermal degradation.
10. The harvested crop must be protected from pests, mice/rodents, livestock and domestic animals. Any pest control measures taken should be documented.

DRYING

When medicinal plant materials are prepared for use in dry form, the moisture content of the material should be kept as low as possible in order to reduce damage from mould and other microbial infestation.

Medicinal plants can be dried in a number of ways

1. In the open air (shaded from direct sunlight);
2. Placed in thin layers on drying frames, wire-screened rooms or buildings.
3. By direct sunlight, if appropriate.
4. In drying ovens/rooms and solar dryers.
5. By indirect fire; baking; lyophilization; microwave; or infrared devices.
6. Vacuum drying
7. Spray dryer: Examples: Papaya latex and pectin's, etc.

- The most common method for preserving plant material is drying.
- Enzymatic processes take place in aqueous solution. Rapid removal of the water from the cell will, therefore, largely prevent degradation of the cell constituents.
- •Drying also decreases the risk of external attack, e.g. by moulds.
- leaves may contain 60-90% water, roots and rhizomes 70-85%, and wood 40-50%. The lowest percentage, often no more than 5-10%, is found in seeds.
- To stop the enzyme processes, the water content must be brought to about 10 %.
- The plant material is spread out on shallow trays, which are placed on mobile racks and passed into a tunnel where they meet a stream of warm air.
- The air temperature is kept at 20-40 °C for thin materials such as leaves, but is often raised to 60-70 °C for plant parts that are harder to dry, e.g. roots and barks.
- When the crude drug has been collected under primitive conditions, without access to a drier, it must be dried in the open.

STORAGE OF CRUDE DRUGS

1. Storage facilities for medicinal material should be well aerated, dry and protected from light, and, when necessary, be supplied with air-conditioning and Humidity control equipment as well as facilities to protect against rodents, insects.
2. The floor should be tidy, without cracks and easy to clean. Medicinal material should be stored on shelves which keep the material a sufficient distance from the walls; measures should be taken to prevent the occurrence of pest infestation.
3. Continuous in-process quality control measures should be implemented to eliminate substandard materials, contaminants and foreign matter prior to and during the final stages of packaging.
4. Processed medicinal plant materials should be packaged in clean, dry boxes, sacks, bags or other containers in accordance with standard operating procedures and national and/or regional regulations of the producer and the end-user countries.

5. Materials used for packaging should be non-polluting, clean, dry and in undamaged condition and should conform to the quality requirements for the medicinal plant materials concerned. Fragile medicinal plant materials should be packaged in rigid containers.

6. Dried medicinal plants/herbal drugs, including essential oils, should be stored in a dry, well-aerated building, in which daily temperature fluctuations are limited and good aeration is ensured

7. Fresh medicinal plant materials should be stored at appropriate low temperatures, ideally at 2-8°C; frozen products should be stored at less than -20°C.

8. Small quantity of crude drugs could be readily stored in air tight, moisture proof and light proof container such as tin, cans, covered metal tins or amber glass containers.

9. Wooden boxes and paper bags should not be used for storage of crude drugs.

PRESERVATION OF PLANT MATERIAL

The plant material must first be preserved so that the active compounds will remain unchanged during transport and storage.

The cells of living plants contain not only low molecular-weight compounds and enzymes, but they also have many kinds of barriers that keep these constituents apart.

When the plant dies, the barriers are quickly broken down and the enzymes then get the opportunity to promote various chemical changes in the other cell constituents, e.g. by oxidation or hydrolysis.

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