Pharmacognosy and Phytochemistry

Introduction-Part 2

B. Pharm. Semester-1

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Learning Outcomes

- **At the end of this lesson students will be able to explain**
  - **Official and Unofficial Drugs**
  - **Monograph, Pharmacognostical Scheme**
  - **Cultivation**
  - **Advantages of Cultivation**
  - **Production of crude drugs:-**
    - **Source material**
    - **Environmental conditions**
    - **Cultivated and wild plants**
    - **Collection**
    - **Drying**
    - **Storage**
    - **European regulations**

Objective

The objective of this course is to give to the students of pharmacy the basic knowledge about the Medicinal Plants and discussion of Medicinal Plants according to their uses and their effects upon the different organs of the body.

Official and Unofficial Drugs

- Drugs of therapeutic value are standardized in the national pharmacopeias, each 5 years.
- Between versions, supplementary books are issued.
- The pharmacopoeia nowadays includes the descriptive material pertaining (belonging) to any of the drugs or preparations.
- This descriptive material is also included in the national formulary سجل الوصفات الوطني.
- This is known as the monograph [**a detailed written study of a single specialized subject**].

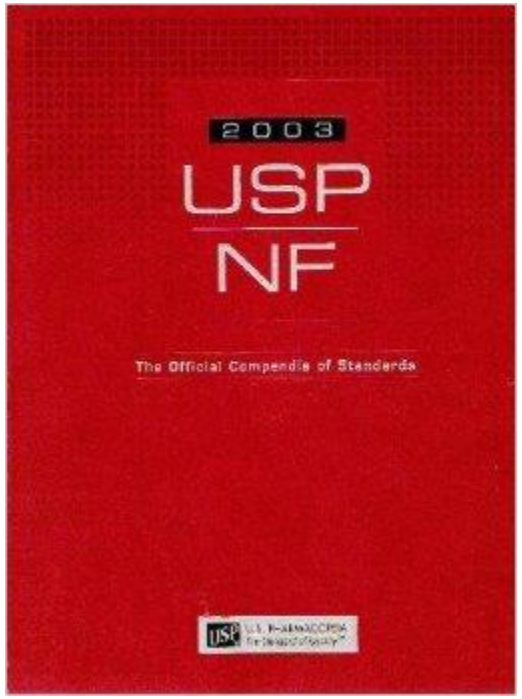
Monograph

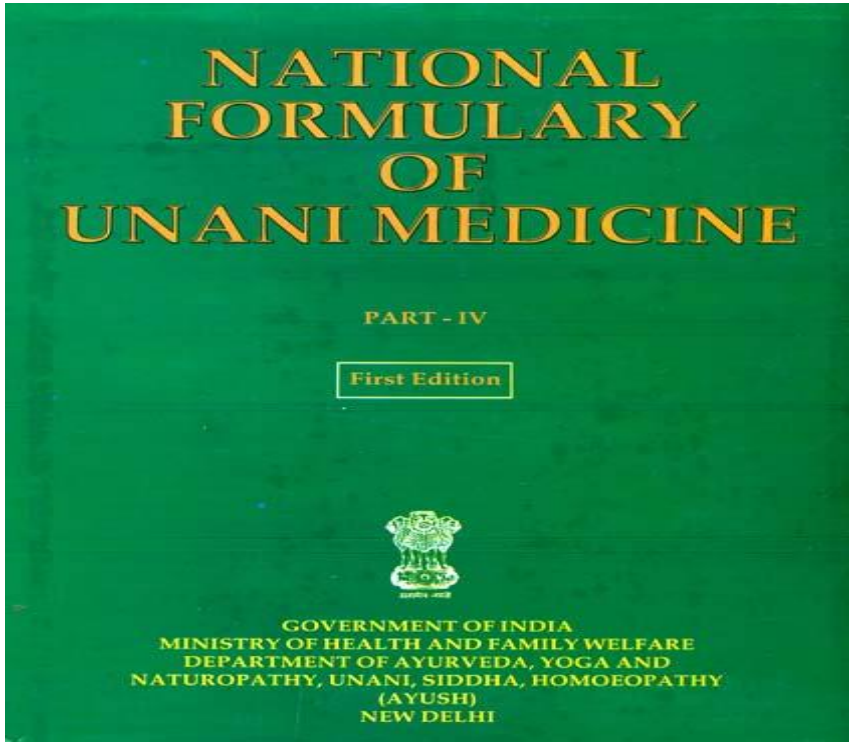
➢Monograph of a drug includes the following information:-

1. Official title
2. Category
3. Dose
4. Definition
5. Description
6. Identity tests
7. Tests for adulterants
8. Method of assay
9. Packaging and storage
10. Tests for foreign organic matter.

Official Drugs

- Drugs meet the requirements of the National formulary and described in the current pharmacopeias are called official.





Unofficial and Non-official Drugs

- Drugs or substances that have been recognized in the pharmacopeias or in the formulary but are **not presently found** in the current issues are designated as unofficial.
- Substances that have never appeared in either book may be called **non-official**.

Pharmacognostical Scheme

Describing drugs in a systematic manner is known as Pharmacognostical Scheme:-

1. Biological Source
2. Geographical Source
3. Cultivation, collection, and preparations
4. Morphological Characters
5. Microscopical Characters
6. Chemical constituents
4. Pharmacological uses
5. Substituents
6. Adulterants
7. Chemical tests

Geographic source or habitat

It is the region in which the plant or animal yielding the drug grows.

Drugs are collected in all parts of the world, though the tropic and subtropics yield more drugs than do the arctic and subarctic e.g. Asia Minor (Anatolia) yields more quantity of drugs than any other region in the world.

Indigenous plants

Indigenous plants: plants growing in their native countries are said to be indigenous to those regions for example Aconitum napellus البيش in the mountains of Europe.

Naturalized Plants

Plants growing in a foreign land or in a locality other than their native homes, as *Datura stramonium* which has been introduced into the United States from Europe.

Some of these plants may have been introduced with the seeds of cultivated plants, some by birds or ocean currents.

Cultivation

It is important that when plants are cultivated in a certain geographical area to ascertain that they will develop the desired type and amount of active constituents.

For example *Ammi visnaga* الخلة البلدية growing wild in the Mediterranean area contains a variety of coumarins and chromones in its seeds, when this plant was cultivated in Arizona, the seeds were devoid of the desired constituents.

Cinchona: native to the South America, was developed as a crop in Indonesia.

Advantages of Cultivation over the collection from wild plants

1. Soil, shade, moisture and plant disease are all readily controlled for the optimum development of the plants.
2. Easier harvesting as plants are almost in the same stage of growth, and exist in smaller areas, consequently, it is made easier to deal with the plants.
3. Quick and efficient drying which yields almost unchanged active ingredients.
4. Extraction of the desired constituents can be done directly in association with cultivation, e.g. essential oil production.
5. Cultivation can be combined with plant breeding to yield higher amounts of active constituents.

The Production Crude Drugs

The crude drug which finally reaches the pharmaceutical manufacturing line will have passed through various stages, all of which can influence the nature and amount of active constituents present (quality & quantity).

These aspects will be considered under the headings: **Source material**, **environmental conditions, cultivated and wild plants**, **collection**, **drying** and **storage, European regulations**.

Production Crude Drugs: Source material

- It is imperative that correct identification of the source material is made.
- Adulteration may be accidental, particularly if collection is made from wild plants, or it may be deliberate.
- Failure in this area can result in poisoning.
- For pharmacopoeial drugs, precise macroscopic and microscopic characters are available.
- For the isolation of specific constituents, the source can vary.

  e.g. particular steroids may be obtained from various diverse plants

  or hyoscine from a number of solanaceous species.

Production Crude Drugs: Environmental conditions

- Plant growth and development, and often the nature and quantity of secondary metabolites, are affected by **temperature**, **rainfall**, **length of day** (including the quality of light) and **altitude**.
- Such effects have been studied by growing particular plants in different climatic areas and observing variations.
- Seeds of cannabis, grown in England and rich in CBD and devoid of THC, when cultivated in Sudan started to produce THC in the first generation and in the second generation contained up to 3.3% THC with a further decrease (down to 0% in some plants) of CBD.

Temperature

- Temperature is a major factor controlling the **development** and **metabolism** of plants.
- Although each species has become adapted to its own natural environment, plants are frequently able to exist in a considerable range of temperature.
- Night and day temperature must also be considered.
- For example, the formation of **volatile oils** appears to be enhanced at higher temperature, although very hot days may lead to an excess physical loss of oil.
- Several authors have indicated that fixed oils produced at low temperatures contain fatty acids with a higher content of double bonds than those formed at higher temperatures.

Rainfall

- The important effects of rainfall on vegetation need to be considered in relation to the annual rainfall, its distribution throughout the year, its effect on humidity and its effect coupled with the water-holding properties of the soil.
- Variable results have been reported for the production of volatile oil, which is coupled with development of glandular hair.
- Continuous rain can lead to a loss of water-soluble substances from leaves and roots by leaching, which results in low yield of active constituents.
- With *Cassia angustifolia* (Tinnevelly senna) it has been shown that short-term drought increases the concentration of sennosides A+B but in the longer term causes loss of leaf biomass.

Length of the day and radiation

- Plants vary much in both the amount and intensity of the light which they require. In the wild state, plant will be found where its shade requirements are met.
- In case of cultivation, similar shade conditions must be provided.
- Research shown that light is a factor which helps determine amount of glycosides, alkaloids; they increase with increase in day length (as in *Cinchona ledgeriana*, and an increase of hyoscine has been noticed in *Datura stramonium* upon exposure to intense light).
- Also, peppermint leaves produce volatile oil rich with menthol with longer day light, while it is rich in other constituents with shorter day light.

Altitude

- The coconut palm needs a maritime (marine) climate and the sugar cane is a low-land plant.
- Some active constituents of medicinal plants either increase or decrease with high attitude, for example, medicinal rhubarb, tragacanth and cinchona require elevation (high attitude).
- Cinchona grows well at low levels but produce no alkaloids.
- The bitter constituents of *Gentiana lutea* كوشاد أصفرincrease with altitude, whereas, the alkaloids of *Aconitum napellus* and *Lobelia inflata* and the oil content of thyme and peppermint decrease.
- Pyrethrum gives the best yields of flower-heads and pyrethrin at high altitudes near the Equator, consequently, it is produced in East Africa and north-west South America.

Cultivated and Wild Plants

- Certain drugs are now almost exclusively from cultivated plants, for example cardamoms, ginger, fennel, opium, and Indian hemp for the production of oil.
- In other cases, both wild and cultivated plants are used.
- Some plants have been cultivated from time immemorial سحيق; others are now grown because supplies of the wilds plants are insufficient to meet the demand.
- Cultivation is essential in the case of drugs such as Indian hemp and opium, which are subject to government control, and in many cases it is advisable because of the improved quality of the drugs which is possible to produce.
- Small changes in ecology can affect plant products; thus, satisfactory rubber trees grow wild in the Amazon.

Cultivated and Wild Plants

Advantages of cultivated plants over wild plats are:-

(1) When supplies from wild plants are insufficient, cultivated plants are useful.

(2) In case of controlled drugs such as hemp and opium that are submitted to governmental control to minimize or prevent abuse.

(3) To produce drugs with higher quality and quantity.

Soils

Different plant species vary enormously in their soil and nutritive requirements, and this aspect has received considerable attention with medicinal plants.

Three important basic characteristics of soils are their physical, chemical and microbiological properties.

Cultivated and Wild Plants

Propagation from seeds

- ✓ To ensure success the seeds must be collected when perfectly ripe.
- ✓ If not planted immediately, they should normally be stored in a cool and dry place.
- ✓ Some seeds such as cinnamon, coca and nutmegs rapidly lose their power of germination if allowed to dry or if stored for quite short periods.

Propagation by vegetative means

- ✓ By the development of bulbs (e.g. squill); corms (e.g. colchicum); tubers (e.g. jalap and aconite); or rhizomes (e.g. ginger).
- ✓ By division, a term usually applied to the separation of a plant which has a number of aerial stems or buds, into separate parts each having roots and a growing point.

Collection of Crude Drugs

- The drugs may be collected from the wild or cultivated plants, and the task may be undertaken by casual, **unskilled** native labor or by **skilled** workers in a scientific manner.
- **The season** is importance since the **amount** and sometimes the **nature** of the active constituents is not constant throughout the year.

- **For example:** **Rhubarb** الراوند contains no anthraquinone glycosides derivatives in **winter** but **anthranols** which, on the arrival of the **warmer** weather, are converted by oxidation into anthraquinones.
- Anthranol-type glycosides are the reduced form of anthraquinones, and are more active.

Collection of Crude Drugs

- The age of the plant is also important as it governs the quantity.
- There is increasing evidence that the composition of a number of secondary plant metabolites varies appreciably throughout the day and the night.
- The most advantageous time of collection is during that period when the plant part constituting the drug is highest in its content of active constituents.
- Example: Suitable time of harvesting is Ephedra species, where the content of alkaloids is highly variable, and reaches the maximum in autumn.

Rules to be followed while Collection of Crude Drugs

- The leaves are collected as the flowers are beginning to open, flowers just before they are fully expanded, and underground organs as the aerial parts die down.
- Leaves, flowers and fruits should not be collected when covered with dew or rain.
- Roots and rhizomes are collected at the end of the vegetation period (i.e. usually in autumn). In most cases, they must be washed free of adhering soil and sand.
- Bulbs: Late autumn, best after the plant has flowered and fruited.
- Bark: In autumn after leaf fall, or spring before the development of the leaves. In spring, the cambium shows its maximum activity producing an abundance of undifferentiated cells that are still soft making stripping the bark, existing outside the cambium, easier.
- It is also approved to collect the bark after rain has fallen, as the bark will be damp and easy to be removed.

Rules to be followed while Collection of Crude Drugs

- Leaves and herbs are collected at the flowering stage. It is preferred to collect the stems with the leaves, and separate them from each other later. Collection in the morning is important in some cases as with Solanaceous leaves.

- Flowers: usually when fully developed. Collection should be in dry weather and towards the middle of the day, after dew has dissipated. In certain cases, as with cloves (Eugenia caryophyllata), the unopen flower is picked.

- Fruits and seeds: when fully ripe and grown, or nearly grown.

Drying of Crude Drugs

- Drying is the most common method for preserving plant material.
- Rapid removal of water guarantees enzymatic activity cessation, and hence, eliminating to a high extent the degradation of the active components.
- Also, it decreases the external attack, (e.g. by fungi).
- Generally, drying is done at relatively high temperatures to guarantee quick drying.
- The chosen temperature should guarantee quick drying (whenever needed), and be suitable for a lot of components that are sensitive to heat.
- Many fresh drugs contain a considerable amount of water (60-90%), and all moist drugs liable to develop mould, so they must be dried, as soon as possible.
- If enzyme action is to be encouraged, SLOW drying at a moderate temperature is necessary.
- If enzyme action is not desired drying should take place AS SOON AS possible after collection.

Drying of Crude Drugs

- The duration of the drying process varies from a few hours to many weeks, and in the case of open-air drying depends very largely on the weather.
- Drying by artificial heat is more rapid than open-air drying and is often necessary in tropical countries (e.g. West Africa, where the humidity is very high).
- Drying in a tobacco barn, greenhouse or oven, and freeze-drying was generally satisfactory for taxol and cephalomannine recoveries.
- Rapid drying helps flowers and leaves to retain their colour and aromatic drugs their aroma.
- As a general rule, leaves, herbs and flowers may be dried between 20 and 40°C, and barks and roots between 30 and 65°C.
- Drugs such as aloes and opium may require further drying after importation.

Storage of Crude Drugs

- The large-scale storage of drugs is a considerable undertaking.
- Except in a few cases, such as cascara bark, long storage, although often unavoidable, is not to be recommended.
- Drugs such as Indian hemp and sarsaparilla deteriorate even when carefully stored.
- It has been reported that the content of taxol in Taxus baccata leaves and extracts stored at room temperature for one year decreased by 30–40%.
- Similarly the alkamides of the popular immunostimulant herb *Echinacea purpurea* decrease rapidly on storage.
- Although drying has little effect on the quantity of alkamides, storage for 64 weeks at 24° produces an 80% loss.

Storage of Crude Drugs

- Drugs stored in the usual containers—sacks, bales, wooden cases, cardboard boxes and paper bags-reabsorb about 10–12% or more of moisture.
- They are then termed ‘air-dry’. Plastic sacks will effectively seal the contents.
- Drugs such as digitalis and Indian hemp should never be allowed to become air-dry or they lose a considerable part of their activity.
- They may be kept in sealed containers with a dehydrating agent.
- Volatile oils should be stored in sealed, well-filled containers in a cool, dark place. Similar remarks apply to fixed oils, particularly cod-liver oil.
- In order to reduce undesirable microbial contamination and to prevent the development of other living organisms, some plant materials may require sterilization before storage.

European Regulations

- To ensure that satisfactory standards for the growing and primary processing of medicinal and aromatic (culinary) herbs are achieved throughout the European Union ‘Guidelines for Good Agricultural Practice of Medicinal and Aromatic Plants’ was issued as a final European version in August 1998.
- It covers seeds and propagation, cultivation, harvesting, primary processing, packaging, storage and transport, personnel and facilities, documentation, education and quality assurance.

REFERENCES

Textbooks:

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2. **Textbook of Pharmacognosy and Phytochemistry 2nd Edition, 2019, Authors: B. Shah, A. N. Kalia, Publisher: Elsevier, ISBN: 978-978-9386217738.**
3. **Medicinal Natural Products: A Biosynthetic Approach, 2nd Edition, 2002, Author: Paul M Dewick, Publisher: John Wiley and Sons Ltd, ISBN: 0471496405.**

Supplementary book:

Fundamentals of Pharmacognosy and Phytotherapy. A Guide for Health Care Professionals by Carol A. Newal, Linda A. Anderson and J. David Phillipson. (2010). the Pharmaceutical Press, London, UK; ISBN: 0 85369-474-5.