Name of Unit	Introduction to Pharmacognosy, Classification and Quality control of crude drugs
Subject Name	Pharmacognosy & Phytochemistry-1
Course/Subject Code	BP405T
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Learning Outcome of Module 01

LO	Particular	Course Outcome Code
LO 1	Students will learn about Meaning, scope and development of Pharmacognosy	BP405.1
LO 2	Students will learn about meaning and types of crude drugs and various sources of crude drugs	BP405.1
LO 3	Students will learn about different types of classification for crude drugs	BP405.1
LO 4	Students will learn about Adulteration and various methods of adulteration	BP405.1
LO 5	Students will learn about meaning of quality control and various methods to standardize a crude drug and to check adulteration.	BP405.1

Content Table

Topic
• Pharmacognosy Introduction, Scope and development • Various sources of drugs • Classification of crude drugs • Adulteration and its types • Quality control methods

INTRODUCTION

Pharmacognosy- It is a branch of Science dealing with crude drugs obtained from natural sources. In broad sense, Pharmacognosy deals with the history, distribution, cultivation, collection, preparation, identification, evaluation, preservation and uses of crude drugs and their derivatives obtained mainly from Plants and animals.

The word 'Pharmacognosy' derived from two Greek words- '*Pharmacon*' means a drug and '*Gignosco*' means to acquire knowledge of.

The word 'Pharmacognosy' was first coined by a German scientist "C. A. Seydler" in 1815 in the title of his work "Analecta Pharmacognostica".

History of Pharmacognosy- Divided in four parts-

1. **Primitive Era-** Pharmacognosy has been developed from ancient civilization who used parts of plants and animals for healing, eliminate pain, control suffering and to treat diseases. The primitive man tried to understand the rationale behind use of the crude drugs and transfer his knowledge by mouth and later on by carving on to stones and clays and then writing on parchment or paper.
2. **Pre-Christian Era-** Chinese medicine is the oldest system of this era. Ayurveda also described uses of medicinal plants and Charak samhita & Susruta samhita were compiled during this phase. Papyrus ebers of Egypt described about 700 medicinal plants and Theophrastus is known for his work on plant kingdom of this era.
3. **Era after Christ-** Dioscoroides a Greek Physician, described a variety of medicinal plants in his manuscript "De Materia Medica" in 78 AD. Many scientists work like Galen, Parcelsus, Willium Turner, Le-Mary & Willium Withering is still known for their contribution in development of Pharmacognosy. Dersone isolated Narcotine and Serturner isolated Morphine from Opium.
4. **Modern Pharmacognosy-** Starting from 1815, there was rapid growth and development in subject of Pharmacognosy along with growth of other subjects and development of modern techniques for plant drugs. During this era Penicillin and Streptomycin antibiotic was isolated. A number of plant drugs were also identified as potential curative agents for many serious diseases. For example- Vinca alkaloids Vincristine and Vinblastine as anticancer, Reserpine as antihypertensive, Digitoxan and Digoxin as cardiotonic and many more.

Scope of Pharmacognosy

- Pharmacognosy is critical in development of different disciplines of science. The knowledge of plant taxonomy, plant breeding, plant pathology and plant genetics is helpful in the development of cultivation technology for medicinal and aromatic plants.
- Pharmacognosy is important branch of pharmacy which is playing key role in new drug discovery and development by using natural products.
- Pharmacognosy is an important link between pharmacology and medicinal chemistry.
- By means of Pharmacognosy, natural products can be dispensed, formulated and manufactured in dosage forms acceptable to modern system of medicine.
- Development of Pharmacognosy also leads to development of botany, taxonomy, plant biotechnology, plant genetics, plant Pathology, Pharmaceutics, Pharmacology, Phytochemistry and other branches of science.

SOURCES OF DRUGS

Plants- Plant source is the oldest source of drugs. Most of the drugs in ancient times were derived from plants. Almost all parts of the plants are used i.e. leaves, stem, bark, fruits and roots etc. For example leaves of *Digitalis purpurea* are the source of Digitoxin and Digoxin, which are cardiac glycosides.

Animals- Pancreas is a source of Insulin, used in treatment of Diabetes. Sheep thyroid is a source of thyroxin, used in hypertension. Cod liver is used as a source of vitamin A and D. Blood of animals is used in preparation of vaccines. Cochineal (dried full grown female insects) consists of carminic acid used as colouring agent for foods, drugs and for cosmetic products.

Plant Tissue Culture- It is *in-vitro* cultivation of plant cell or tissue under aseptic and controlled environmental conditions, in liquid or on semisolid well- defined nutrient medium for the production of primary and secondary metabolites or to regenerate plant. This technique affords alternative solution to problems arising due to current rate of extinction and decimation of flora and ecosystem. Applications are Production of Phytopharmaceuticals, Biochemical Conversions Clonal Propagation (Micro-propagation), Production of Immobilized Plant Cell and Sources of drugs of natural origin.

Marine Sources- The greater part of the earth surface is covered by seas and ocean, which contains about 5,00,000 species of marine organisms. Many of these compounds have shown pronounced biological activity. In the western medicine agar, alginic acid, carrageenan, protamine sulphate, spermaceti & cod and halibut liver oils are the established marine medicinal products. Macroalgae or seaweeds have been used as crude drugs in the treatment of iodine deficiency states such as goiter, etc. Various examples are-

1. Anticancer drug- Bryostatins, Dolastatins, Ara-C
2. Anti-inflammatory drugs- Pseudoterosins, bi-indole, Manoalide
3. Cardio-vascular drugs- Anthopleurins, Laminine, Saxitoxin
4. Anthelmintic drugs- Kainic acid, Domoic acid
5. Antimicrobial drugs- Cephalosporin, Istamycin, Nitenin

Crude drug and its types-

Crude drugs- It means the natural substances from vegetable and animal sources that have undergone no any processing other than collection and drying. These are also called as Simples or Simple drug. These are of two types-

Organized drugs (Cellular drugs)	Unorganized drugs (Acellular drugs)
1. These are organs of plants or animals and are made up of cells or definite structure. Examples- Flower, fruit, seed, leaf, root, stem etc. 2. Solid in nature and studied and identified by structural features. 3. Examples- Leaf- Digitalis, Root- Ruwolfia, Stem- Ephedra, Fruit- Fennel, Flower- Clove	1. These are derived from parts of plant or animal by some process of extraction and followed by purification, if necessary. Examples- Extracts, juices, lattices, gums, mucilage, resin etc. 2. Solid/ Semi solid/ liquid in nature and can be studied or identified by Chemical and physical parameters 3. Examples- Extracts- Agar, Juices- Aloe, Lattices- Opium, Gum- Acacia, Mucilage- Isabgol

CLASSIFICATION OF DRUGS

The most important natural sources of drugs are higher plant, microbes and animals and marine organisms. Some useful products are obtained from minerals that are both organic and inorganic in nature. In order to pursue (or to follow) the study of the individual drugs, one must adopt some particular sequence of arrangement, and this is referred to a system of classification of drugs. A method of classification should be:

- simple
- easy to use
- free from confusion and ambiguities.

Because of their wide distribution, each arrangement of classification has its own merits and demerits, but for the purpose of study the drugs are classified in the following different ways:

- Alphabetical classification
- Taxonomical classification
- Morphological classification
- Pharmacological classification
- Chemical classification
- Chemotaxonomical classification
- Serotaxonomical classification

Alphabetical Classification

It is the simplest way of classification of any disconnected items. Crude drugs are arranged in alphabetical order of their Latin and English names (common names) or sometimes local language names (vernacular names). Some of the pharmacopoeias, dictionaries and reference books which classify crude drugs according to this system are as follows:

1. Indian Pharmacopoeia
2. British Pharmacopoeia
3. British Herbal Pharmacopoeia
4. European Pharmacopoeia
5. United States Pharmacopoeia and National Formulary

Merits

It is easy and quick to use. There is no repetition of entries and is devoid of confusion. In this system location, tracing and addition of drug entries is easy.

Demerits

There is no relationship between previous and successive drug entries.

Examples:

Acacia, Benzoin, Cinchona, Dill, Ergot, Fennel, Gentian, Hyoscyamus, Ipecacuanha, Jalap, Kurchi, Liquorice, Mints, Nux vomica, Opium, Podophyllum, Quassia, Rauwolfia, Senna, Vasaka, Wool fat, Yellow bees wax, Zeodary.

Taxonomical (Biological) Classification

All the plants possess different characters of morphological, microscopical, chemical, embryological, serological and genetics. In this classification the crude drugs are classified according to kingdom, subkingdom, division, class, order, family, genus and species as follows.

Merits

Taxonomical classification is helpful for studying evolutionary developments.

Demerits

This system also does not correlate in between the chemical constituents and biological activity of the drugs.

Pharmacological Classification

Grouping of drug according to their pharmacological action or their therapeutic use is termed as pharmacological or therapeutic classification of drug. This classification is more relevant and is mostly a followed method. For example-

- Drugs like digitalis, squill and strophanthus having cardiotonic action are grouped irrespective of their parts used or phylogenetic relationship or the nature of phytoconstituents they contain.
- Drug acting on G.I.T. **Bitter** Cinchona, Quassia, Gentian **Carminative** Fennel, Cardamom, Mentha **Emetic** Ipecac **Laxative** Agar, Isabgol, Banana **Purgative** Senna, Castor oil
- Drug acting on Respiratory system **Expectorant** Vasaka, Liquorice, Ipecac & **Antitussive** codeine.

Merits This system of classification can be used for suggesting substitutes of drugs, if they are not available at a particular place or point of time.

Demerits Drugs having different action on the body get classified separately in more than one group that causes ambiguity and confusion. Cinchona is antimalarial drug because of presence of quinine but can be put under the group of drug affecting heart because of antiarrhythmic action of quinidine.

Chemical Classification

Depending upon the active constituents, the crude drugs are classified. The plants contain various constituents in them like alkaloids, glycosides, tannins, carbohydrates, saponins, etc. Irrespective of the morphological or taxonomical characters, the drugs with similar chemical constituents are grouped into the same group. It is preferred method for classification. For example-

1. Glycosides- Digitalis, Senna, Cascara.
2. Alkaloids- Cinchona, Datura, Nux-vomica
3. Tannins- Pate catechu, Ashoka
4. Volatile oil- Peppermint, Clove, Eucalyptus
5. Carbohydrates and derived products- Acacia, Agar, Guargum. Etc.

Merits It is a popular approach for phyto-chemical studies.

Demerits Ambiguities arise when particular drugs possess a number of compounds belonging to different groups of compounds.

Chemotaxonomic Classification

This system of classification relies on the chemical similarity of a taxon, i.e. it is based on the existence of relationship between constituents in various plants. There are certain types of chemical constituents that characterize certain classes of plants. This gives birth to entirely a new concept of chemotaxonomy that utilizes chemical facts/characters for understanding the taxonomical status, relationships and the evolution of the plants.

For example, tropane alkaloids generally occur among the members of Solanaceae, thereby, serving as a chemotaxonomic marker. Similarly, other secondary plant metabolites can serve as the basis of classification of crude drugs. The berberine alkaloid in Berberis and Argemone, Rutin in Rutaceae members, Ranunculaceae alkaloids among its members, etc., are other examples.

Merits- It is the latest system of classification that gives more scope for understanding the relationship between chemical constituents, their biosynthesis and their possible action.

Serotaxonomic Classification

On the basis of antiserum properties or protein homogeneity between plants. Proteins most widely used as antigens in serotaxonomy are those, which carry useful taxonomic information and are easy to handle. Both structural and reserve proteins can be used in the field of systematics, as long as they belong to the same group and the same organs are always compared.

For example:

- A close relationship among the Magnoliidae, Hamamelididae and Comiflorae of the angiosperms has been found, based on comparative serological studies of their major seed proteins. This has refuted the idea of their independent evolution.
- The homogeneity of the iridoid-producing Comiflorae has been confirmed by serological studies, which has supported the inclusion of the Gentianaceae in it.
- Based on phytoserological studies, Pickering and Fair brothers (1970) have proposed the classification of the family Umbelliferae into Hydrocotyloideae, Saniculoideae and Apioideae, and Apioideae was found to be more closely related to Saniculoideae than to Hydrocotyloideae.

Merits- It is latest technique for classification and most reliable.

ADULTERATION

It is the process of admixture of genuine articles with spurious, inferior, defective and

artificial substances. These all substances are known as Adulterants. Adulteration can be done by-

Sophistication- Addition of cheap, inferior or spuriousmaterial.

Substitution- Genuine drug is substituted with different drug.

Admixture- Addition of adulterant by accident, ignorance and carelessness.

Deterioration/ Inferiority- Imperfect quality of drug due to destruction or removal of active phytoconstituent.

Spoilage- Drug is destroyed by the action of bacteria, fungi, insect or rodents.

Harmful materials- Addition of harmful materials/ heavy metals.

Adulteration is of two types-

Deliberate/ Intended/ Direct- Done to gain profit.

In deliberate/ Unintended/ Indirect- By fault. Not done for profit. Adulteration can be detected by- Methods of quality control/ Standardization/ Evaluation

In deliberate adulteration-

It may occur due to following reasons-

- By faulty collection of drug at wrong time, in wrong weather or other part is collected. Ex. Collection of Senna stem in place of leaves, Wild cherry bark should be collected in autumn season.
- By imperfect preparation and processing of crude drugs. Example- Cork part is not removed properly from Ginger rhizome, Digitalis leaves are dried at more than 60 degree temperature.
- By improper storage. Example- If volatile oils are not stored properly in air tight amber colour container.
- Due to common vernacular names of different drugs. Example- Brahmi common name for two plants- *Bacopa monnieri* and *Hydracotyl asiatica*

Deliberate adulteration-

It may occur due to following reasons-

- Adulteration with artificially manufactured substance in crude drug.
- Ex. Paraffin wax in Bees wax.
- Adulteration with inferior quality material (sophistication). Ex.

Alexandrian Senna is added in Indian Senna.

- Adulteration with exhausted material. Ex. Volatile oil containing drugs are added with exhausted material.
- Adulteration with harmful substances. Ex. Brick powder is mixed with Chilli powder.
- Adulteration with excessive adventitious material. Ex. Excessive amount of stem in added in Senna.
- Adulteration with superficially similar but inferior drug. Ex. Saffron is mixed with flowers of *Carthamus tinctorious.*
- Adulteration with vegetative material. Ex. The lower plants like mosses, liver worts, epiphytes are added with crude drug

Adulteration can be checked by methods of Evaluation.

EVALUATION/ STANDARDIZATION/ QUALITY CONTROL

Evaluation is an elaborate process of establishing the correct identity of a drug and of determining its quality ad purity. Evaluation of a drug can be done on the spot by using some Organoleptic methods or in the laboratory by the use of microscopical, chemical, biological and physical methods. On this basis various types of evaluation are-

- Organoleptic Evaluation (Macroscopic/ Morphological)
- Microscopic Evaluation
- Chemical Evaluation
- Physical Evaluation
- Therapeutic/ Pharmacological/ Biological evaluation

Organoleptic Evaluation (Macroscopic/ Morphological)-

It involves the use of the organs of sense and depends on the macroscopic appearance and sensory characters of the drug, such as its gross morphology, shape and size, colour and external markings and odour and taste.

Examples-

Camphor- aromatic odour,

Ginger, capsicum-pungent odour.

Cardamom- green colour fruit

Cinnamon- brown color bark

Fractured surface- cinchona

Lemon-sour taste & Honey-sweet

Microscopic Evaluation

It is done with the aid of microscopes and utilizes various microscopic characters of the drugs, such as trichomes, calcium oxalate crystals, starch grains, pollen grains, etc. and their histological features, such as types and arrangements of various cells and tissues. This method of evaluation is indispensable in the evaluation of powdered drugs, as they possess very few macroscopical characters other than colour, odour and taste. Microscope is also essential for determining some important physical constants like stomata number, stomatal index, palisade ratio, vein-islet number, vein termination number, etc. of leaf drugs. This type of microscopical determinations is otherwise known as Quantitative microscopy. It also includes counting of cells by Lycopodium spore method.

Chemical evaluation

It involves both qualitative and quantitative determinations of their active principles. In this method characteristic qualitative chemical tests are employed to identify crude drugs and their constituents. Quantitative chemical assays are used to determine their quality and purity. This method of evaluation is now widely used in the examination of crude drugs for its accuracy and reliability. Various specific chemical tests have been established for identification and quality determination of different drugs.

Generally it is completed in two parts-

- Preliminary phyto-chemical screening
- Particular chemical test for different phyto-constituent

Examples-

- For alkaloids- Dragendroff's test, Mayer's test, Wagner's test
- For cardiac glycosides- Legal test, Baljet test, Killer Killiani test

  For steroids- Liebermann- Burchard reaction
- For carbohydrates- Molish test, Fehling solution test etc.

Biological evaluation

This **Biological evaluation** of crude drugs is very useful in determining the potency of drug sample. In this type of evaluation the extent of pharmacological activity of the drug or its constituents is taken as the basis of quality. Since living organisms or their isolated living tissues are used, this method is also called the biological method or bioassay. Many drugs, particularly the antibiotics, toxins and toxoids and also vitamins are assayed by this method.

Examples-

- Analgesic activity is evaluated by Hot plate method, Tail flick method
- Antipyretic activity is evaluated by Yeast induced pyrexia method
- Anti-inflammatory activity is evaluated by Carageenan induced rat paw edema

Physical Evaluation

The Physical evaluation of crude drugs is accomplished by the determination of various physical constants using various physico- chemical techniques. The common physical constants used to evaluate crude drugs and their extracted chemical principles include specific gravity (particularly of the fats and volatile oils and some crude drugs as Nutgalls), optical rotation (of some alkaloids in solution and of volatile oils), refractive index (particularly of the volatile and fixed oils), melting points (of isolated alkaloids and their derivatives), ash values (of most crude drugs) and extractive values (of most crude drugs). All the above methods and types of evaluation are appropriately used to achieve the various objectives of evaluation of crude drugs, that is, to establish their identity (correct source), purity (absence of adulterants) and quality (presence of required amount of active constituents).

Very Short answer type questions (2 Marks)

1. Define Pharmacognosy.
2. Who coined the word Pharmacognosy?
3. Define crude drugs and its types.
4. Differentiate Organized and unorganized drugs with examples.
5. Give examples of any two drugs obtained from plant sources.
6. Give examples of any two drugs obtained from animal sources.
7. Give examples of any two drugs obtained from plant tissue culture.
8. Give examples of any two anticancer drugs obtained from marine sources.
9. Give examples of any two anti-inflammatory drugs obtained from marine sources.
10. Write any two scope of Pharmacognosy.
11. Define Adulteration and its types.
12. Define……. classification with its merits and demerits.
13. Differentiate the meaning of adulteration and substitution.
14. What do you mean by sophistication? Give example.
15. Which evaluation method you will prefer to identify a crude drug?
16. What do you mean by evaluation/ quality control/ standardization?
17. Define ……..evaluation with example.
18. Define leaf constants.
19. Define quantitative microscopy.

Short answer type questions (5 Marks)

1. Write a brief note on scope of Pharmacognosy.
2. Explain with examples how marine sources are important for crude drugs?
3. Explain with examples how plant tissue culture is important source for crude drugs?
4. Explain different types of deliberate adulteration with example.
5. Discus in brief ……..Classification with examples and advantages and disadvantages.
6. Explain different types of in deliberate adulteration with example.
7. Explain in detail……evaluation with example.

Long answer type questions (2 Marks)

1. Write a detailed note on history, scope and development of Pharmacognosy.
2. Discuss various sources of crude drugs with examples.
3. Write a detailed note on adulteration.
4. What is adulteration? How you can check adulteration?
5. Write a detailed note on various system of classification for crude drugs. Explain which system you will prefer for classification and why?
6. Explain in detail various methods for quality control of herbal drugs.