

## INTRODUCTION TO SECONDARY METABOLITES

### ALKALOIDS

The term "Alkaloid" was proposed by W. Meissner in 1819. The term is derived from the word 'alkali like', so they have some character similar to naturally occurring complex amines. It is difficult to define alkaloids precisely because there is diversity in chemical and physiological activity. So various studies and researches were done on the alkaloids and now a days the alkaloids are defined as **"Alkaloids are the organic products of plant origin, basic in nature and contain one or more nitrogen atoms normally of heterocyclic in nature, and have marked physiological action when administered internally."**

Alkaloids are present in plants- both in free form and salts of organic acid such as quinic, maleic muconic, oxalic acid etc. They are present in different parts of the plant like leaves, fruits, barks, seeds, roots & rhizomes and stems etc. and can be easily extracted. Alkaloids are poisonous in nature but when used in small quantities exert useful physiological action.

As far as nomenclature of alkaloids is concerned there is a lack of any agreed systematic prevailing system. Hence by general agreement the chemical rules suggests that the name of alkaloids must end with the suffix (-ine). For example belladonine and atropine from *Atropa belladonna*, morphine and narcotine from *Papaver somniferum* and ergotamine form *Claviceps purpurea* etc.

### GENERAL PROPERTIES OF THE ALKALOIDS

The properties of alkaloids are discussed under two headings –

**Physical properties** – Almost all the alkaloids are colourless, crystalline solids and possess a sharp melting point. Some alkaloids like nicotine and coniine are liquid and volatile in nature. Some alkaloids are coloured like berberine is yellow and bentanidin is red.

The solubility of various alkaloids and their salts exhibit considerable variation. The free alkaloidal bases are fairly soluble in organic solvents, non polar solvent, and lower alcohols but they are either practically insoluble or very sparingly soluble in water. The alkaloidal salts are freely soluble in water, relatively less soluble in alcohol and very sparingly soluble in organic solvents. For example atropine sulphate and morphine hydrochloride are freely soluble in water than their corresponding bases ie atropine and morphine. The differences of solubilities of alkaloids is utilized for extraction, isolation, purification and assay of alkaloids.

**Chemical properties** – The normal elements present in the alkaloids are carbon, hydrogen and oxygen but every alkaloid should essentially contain at least one nitrogen atom. The nitrogen present in the alkaloid imparts basic properties. The nitrogen in the alkaloids may be primary amine ( $RNH_2$ ) e.g. mescaline, as secondary amine ( $R_2NH$ ) e.g. ephedrine, as tertiary amine ( $R_3N$ ) e.g. morphine and quaternary ammonium compounds ( $R_4N^+X^-$ ) e.g. tubocurarine chloride. Quaternary ammonium compounds are not alkaloids in the true sense



because nitrogen atom does not possess a hydrogen atom and their chemical properties are quite different but as a matter of convenience, they are legitimately grouped along with alkaloids. The degree of basicity of alkaloids mostly depends upon the influence caused due to electrostatic status of the nitrogen atom present in alkaloids. There are certain alkaloids which contain oxygen atom. These type of alkaloids are found in solid state but there are few exceptions where oxygenated alkaloids usually occur as non-volatile liquids for e.g. pilocarpine.

Many alkaloids are optically active. Amongst dextra and levo isomers, the levo isomers are pharmacologically more active.

**Precipitation by specific reagents (Chemical tests of Alkaloids)** – Most of the alkaloids are precipitated with specific reagent. They show characteristic coloured precipitate with specific reagents as mentioned below –

Mayer's reagent (Potassium – Mercuric iodide solution) gives cream colored precipitate.

Wagner's reagent (Potassium Tri iodide solution) gives reddish brown precipitate.

Dragendorff's reagent (Potassium bismuth iodide solution) gives reddish brown or orange red precipitate.

Hager's reagent (Saturated solution of Picric acid) gives yellow colored precipitate.

An utmost care must be taken while performing the above chemical test with alkaloids because proteins, coumarins and a-pyrones also yield precipitate with the above mentioned reagents. Hence the test with heavy metals in some cases may be false. So the specific test of individual alkaloid should be performed which are mentioned under individual drug.

## **CLASSIFICATION OF ALKALOIDS**

There are various methods of classification of alkaloids which are discussed below: –

**Biosynthetic Classification** – In this classification the importance is given to the precursor from which the alkaloids are produced in plant biosynthetically. So all the alkaloids which are derived from the same precursor can be brought under same group even they have different taxonomic distribution and pharmacological activity. For e.g. piperidine alkaloids derived from *lysine*, pyrrolidine alkaloids derived from *ornithine* and indole alkaloids derived from *tryptophan*.

**Pharmacological classification** – The alkaloids exhibit a wide range of pharmacological actions. In this classification alkaloids are classified on the basis of their pharmacological action for e.g. analgesic, CNS stimulant or depressant and anti malarials etc. Hence individual alkaloid may exhibit different action within the same drug for e.g. in cinchona, quinine is an anti malarial where as quinidine is a cardiac depressant, in opium morphine is a narcotic analgesic where as codeine is antitussive. However this classification is not commonly used.

**Taxonomic classification** – This classification deals with the 'Taxon' i.e taxonomic category. Common taxa are like genus, subgenus, species and subspecies etc. In this classification the large number of alkaloids are classified on their distribution in various plant families like rubiaceous alkaloids and solanaceous alkaloids.

Some phytochemists have stepped further and classified alkaloids based on chemotaxonomic classification.

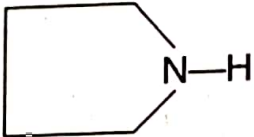
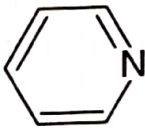
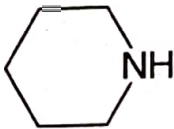
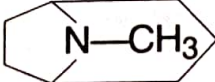
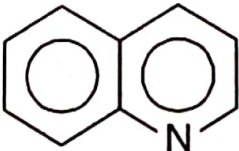
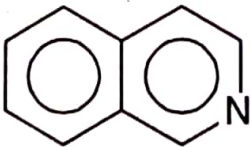
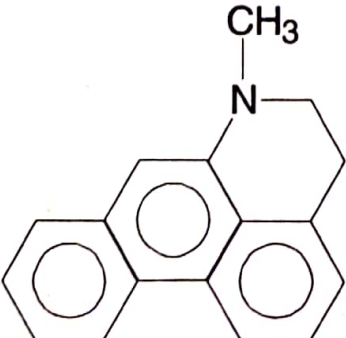


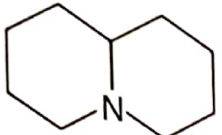
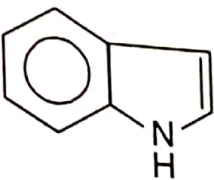
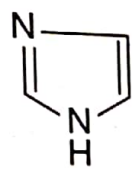
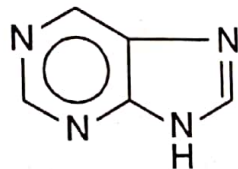
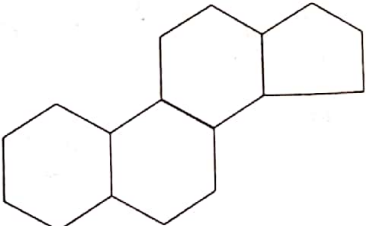
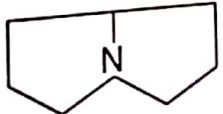
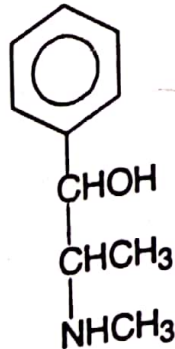
**Chemical classification** – This is the most widely accepted classification of alkaloids. The basis of the classification is the ring structure (normally heterocyclic ring) present in the alkaloids. The alkaloids are divided into two categories viz.:-

Non heterocyclic or Prota alkaloids

Heterocyclic or Typical alkaloids

**Heterocyclic alkaloids** – There are large number of alkaloids which posses heterocyclic ring structure as mentioned below :-

S.No.	Type	Basic ring structure	Examples
1.	Pyrrolidine		Hygrine, Stachydrine
2.	Pyridine		Ricinine, Arecoline
3.	Piperidine		Lobeline, Connine
4.	Tropane [Piperidine-Pyrrolidine (N-Methyl)]		Atropine, cocaine
5.	Quinoline		Quinine, Quinidine, Cinchonidine, Cinchonine
6.	Isoquinoline		Papaverine, Morphine, Emetine, Berberine
7.	Aporphine (reduced isoquinoline/ naphthalene)		Boldine

S.No.	Type	Basic ring structure	Examples
8.	Norlupinane		Sparteine, Lupanine, Cytisine
9.	Indole or Benzopyrrole		Ergotamine, Ergometrine, Reserpine, Brucine, Vinblastine, Vincristine
10.	Imidazole		Pilocarpine, Pilosine
11.	Purine (Pyrimidine/Imidazole)		Caffeine, Theophylline, Theobromine
12.	Steroidal (Cyclopentanoperhydrophenanthrene)		Connesine, Solanidine, Veratramine, Funtumine
13.	Diterpene	$C_{20}H_{32}$	Aconine, Aconitine, Lyctonine
14.	Pyrrolizidine		Senneciphylline, Sennecionine
15.	Amino alkaloids		Ephedrine, Pseudoephedrine



## GENERAL METHODS OF EXTRACTION AND ISOLATION OF ALKALOIDS

The extraction of alkaloids depends upon the following factors:-

the basic nature of alkaloids

the ability of formation of alkaloidal salts with acids

the solubility of the alkaloid either in aqueous medium or in polar organic solvents like alcohol, chloroform, acetone etc.

The extraction of alkaloids is done by following methods. However any one of the following can be used.

**Method 1 :-** The drug is powdered with the help of grinders. It is moistened with water and treated with lime. Then the drug is extracted with organic solvent like petroleum spirit or ether. Filter it and collect the filtrate. To the filtrate add water and separate the organic layer. The organic layer is shaken with aqueous acid and allowed to separate. Reject the organic layer. The aqueous layer obtained contains the alkaloidal salts.

**Method 2 :-** The drug is powdered with the help of grinders. It is moistened with water and treated with acid. Then the drug is extracted with alcohol or water. Filter it and to the filtrate add acetone. Reject the organic layer which contain several impurities. The aqueous layer so obtained contains alkaloids. It is treated with ammonia or sodium bicarbonate and organic solvent is added. Separate the layers. Reject the aqueous layer. The organic layer obtained contains the alkaloids.

From the above methods we will get the crude mixture of alkaloids. So the separation and purification of individual alkaloids can be done by following methods -

✓ **Fractional crystallization** - It is a easy method but it does not give better results in complex mixture

**Steam distillation** - This method is used for volatile liquid alkaloids such as nicotine and coniine.

**Chromatographic techniques** - This is the latest and widely accepted method employed for the separation of individual alkaloids from complex mixtures. The various chromatography techniques used are like thin layer chromatography, high performance thin layer chromatography (HPTLC) high performance liquid chromatography (HPLC), column chromatography, gas chromatography and ion exchange chromatography etc.

## FUNCTIONS OF ALKALOIDS IN PLANTS

Alkaloids play a vital role in the plants. There different types of functions are listed below -

They may have a vital role in growth regulatory factors.

The alkaloids are poisonous in nature thus they protect the plants from grazing animals or insects.

They act as a reserve substances in plant and supply nitrogen or other elements.

They might be the by-products of various detoxification reaction in plants and by this way they cease the formation of harmful substances in plants.

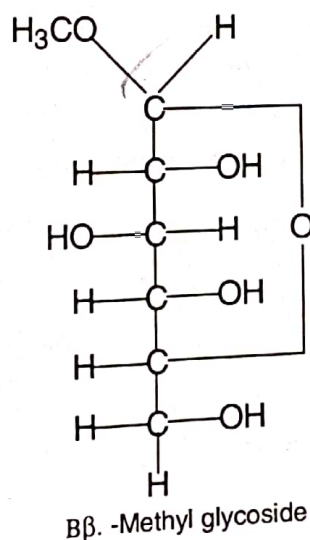
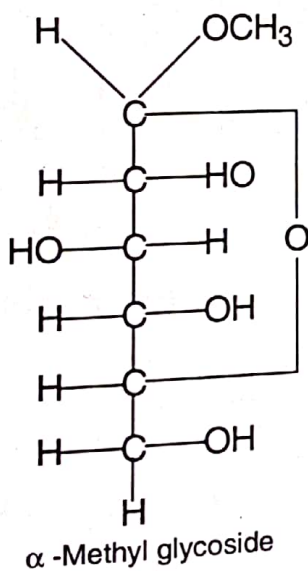
They are present in association with plant acids like quinic acid, cinchotannic acid etc. Hence they may provide the means of storing or transportation of such acids.



**GLYCOSIDES**

Glycosides are the complex organic substances widely distributed in plant kingdom. These organic substances are present in conjugation with sugar moieties. Glycosides exhibit a wide spectrum of pharmacological actions for e.g. like analgesic, purgative, cardiotoxic, demulcent, anti-rheumatic etc. In plants glycosides occur in different parts like leaf, fruit, root, rhizome, bark, seeds, wood etc.

Glycosides can be defined as **"the organic compounds mainly of plant origin and rarely of animal which on enzymatic or acidic hydrolysis yields one or more sugar moieties (Glycone) and a non sugar moiety (Aglycone or Genin)."** Glycosides are considered to be sugar ethers or acetals, and they are formed by condensation of hydroxyl group of non sugar and hemiacetal hydroxyl group of sugar. The sugar (glycone) present in glycosides are monosaccharides like glucose and rhamnose or more rarely deoxysugars such as cymarose found in cardiac glycosides. The aglycone part may be alcohol, phenol or amines. The linkage between glycone and aglycone is known as glycosidic linkage and on this basis of linkage a and b stereo isomers are assigned. Practically all natural glycosides, however are of b-type. The simplest glycosides are a-methyl glycosides and b-methyl glycosides which can be synthesized from union of methyl alcohol and glucose.



**PROPERTIES OF GLYCOSIDES**

Glycosides are colourless compounds but some of them are coloured like flavonoids are yellow and anthracene glycosides are red.

They are crystalline or amorphous solid compound.

Glycosides are optically active and normally levo form is more active.

Glycosides are soluble in water and alcohol but insoluble in chloroform and ether.

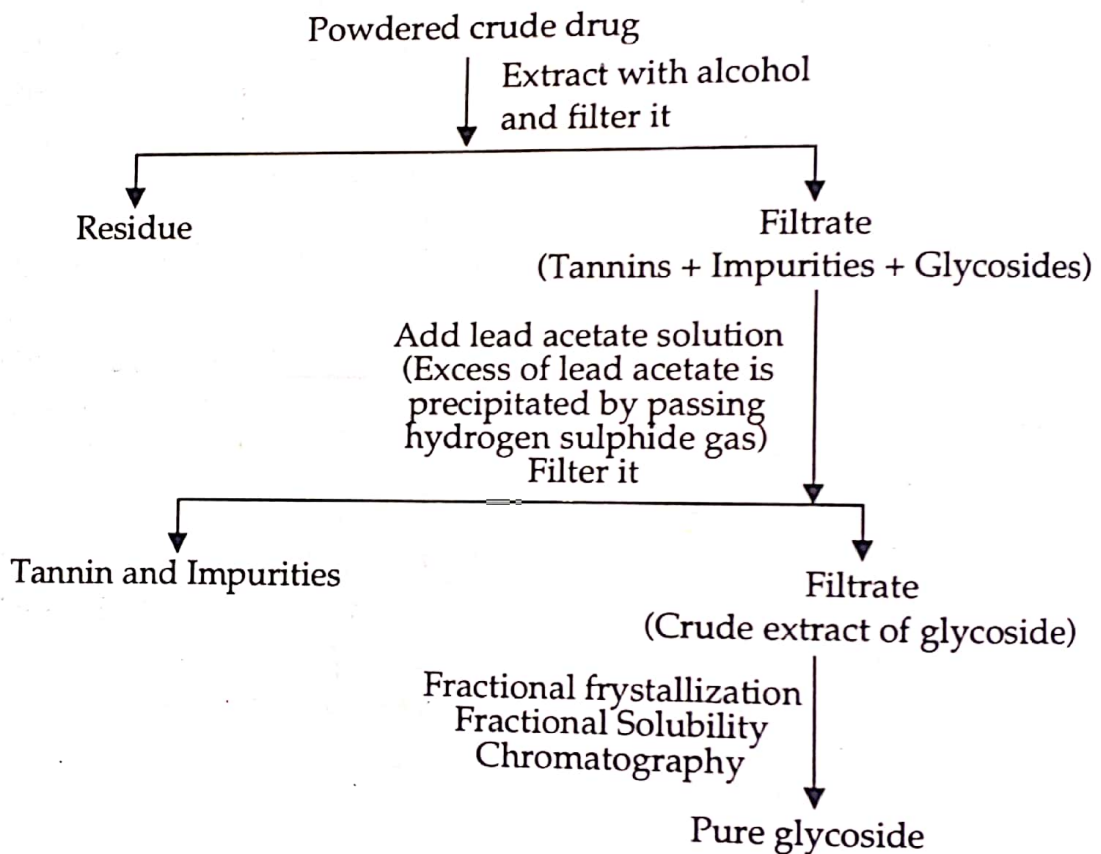
Glycosides can be hydrolyzed by mineral acids, water and enzymes.

**ISOLATION - (STAS-OTTO METHOD)**

The glycosides are extracted by using Stas-Otto Method. The drug is powdered by grinders. The powdered drug is extracted with alcohol by continuous hot percolation method.

By this process all the enzymes present in the plant parts are deactivated. The extract obtained is treated with lead acetate solution which precipitates out the tannins and other impurities. The excess of lead acetate is precipitated by passing hydrogen sulphide gas through solution. The extract is filtered and the filtrate is concentrated. From this concentrated crude extract the pure glycosides can be obtained by using fractional crystallization, fractional solubility and chromatographic techniques. Chromatography is the latest and widely accepted technique used now days. The characterization of isolated pure glycoside can be done by using UV, Visible, I.R, N.M.R and Mass spectrometry analysis.

The above Stas-Otto-Method is illustrated below.



**Identification test** - These are no simple identification test for glycosides. Depending upon the nature of glycone and aglycone moiety specific chemical test of the drugs are performed which are mentioned in individual drugs.

## CLASSIFICATION OF GLYCOSIDES

The glycosides are classified in the following four ways-

- (1) On the basis of the type of the sugar or the glycone part for e.g. glucosides with glucose, fructoside with fructose and pentosides with pentose etc.
- (2) Glycosides are classified on the basis of the pharmacological action exhibited by them. For e.g.

Purgative glycosides - Aloe, Senna

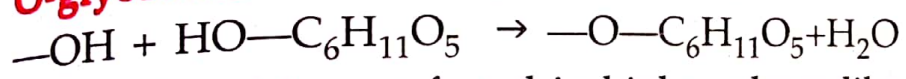
Cardiac glycosides- Digitalis, Thevetia



Diuretics - Gokhru

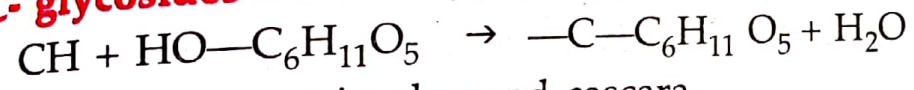
3. Glycosides are also classified on the basis of linkage between glycone and aglycone part. The exact point of linkage between glycone and aglycone portion is an oxygen bridge which connects the reducing group present in glycone to either alcoholic or phenolic group present in the aglycone. Such glycosides are called as O-glycosides. However, if 'O' is replaced by 'C' it is called as C-glycosides, if replaced by 'S' it is called as S-glycosides and if replaced by 'N' it is called as N-glycosides as mentioned below :-

**O-glycosides** - In these glycosides sugar is connected to OH or phenol group.



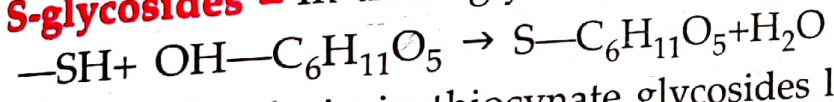
These glycosides are found in higher plants like rhubarb and senna etc.

**C-glycosides** - In this type of glycosides sugar is connected to carbon atom.



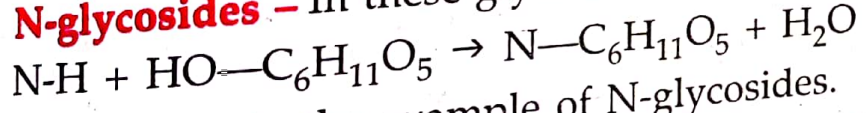
These are present in aloe and cascara.

**S-glycosides** - In these glycosides Sulphur of SH group is attached to the sugar.



It is found only in isothiocynate glycosides like sinigrin from black mustard.

**N-glycosides** - In these glycosides N of NH (amino group) is attached to the sugar.



Nucleosides is the example of N-glycosides.

4. Glycosides are also classified on the basis of the chemical nature of the aglycone moiety. This is the most widely accepted classification. They are grouped as -

1. Anthracene or Anthraquinone glycosides
2. Saponin glycosides
3. Cardiac glycosides
4. Cyanogenetic or Cyanophoric glycosides
5. Isothiocynate glycosides
6. Coumarin and Furanocoumarin glycosides
7. Aldehyde glycosides
8. Steroidal glyco-alkaloids
9. Phenol glycosides
10. Flavonoid glycosides
11. Bitter glycosides and Miscellaneous glycosides



## TANNINS

Tannins are widely distributed in plant kingdom. As the name indicates they possess the property to 'tan' i.e. to convert hide and skin into leather. So tannin is a substance which is detected qualitatively by tannins test i.e. the Goldbeater's skin test. These are secondary metabolites and are present in cell sap and vacuoles. They act as astringent as they have the capacity to combine with proteins and precipitate them. Tannins can be defined as "**the complex, organic, non-nitrogenous, polyphenolic substances of higher molecular weight.**" They are used as antiseptics and in gastro-intestinal diseases like diarrhoea. They are also used in leather industries.

### PROPERTIES

Tannins are soluble in water, alcohol, dil alkalis, glycerine and acetone but are insoluble in organic solvent such as benzene, ether and chloroform.

They should possess tanning properties.

Tannins with ferric salts give blue, black, violet or green colour.

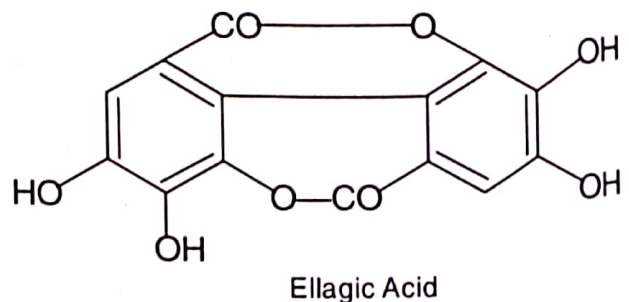
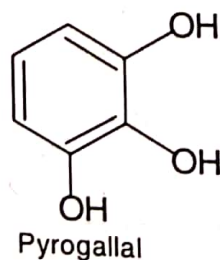
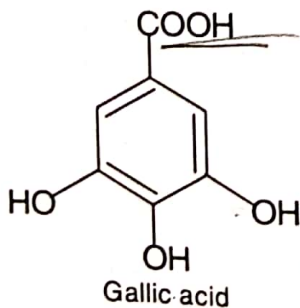
Tannins give precipitate with alkaloids and heavy metals therefore they are used as antidotes in alkaloidal and heavy metal poisoning.

In aqueous solution tannins produce acidic reaction and have astringent taste.

**Classification** - Tannins are classified in two classes on the basis of chemical nature as follows -

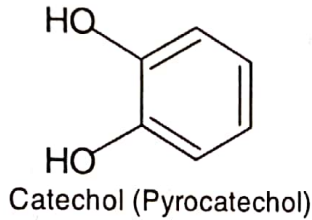
1. Hydrolysable tannins
2. Condensed tannins.

**1. Hydrolysable tannins** - These tannins are hydrolyzed by acids or enzymes and produce gallic acid or ellagic acid. Chemically they are esters of sugar usually glucose with one or more trihydroxybenzene carboxylic acid. With ferric chloride they produce blue colour, hence they are used in manufacture of ink. When these tannins are heated, pyrogallol is produced. The examples of hydrolysable tannins are gallotannin from rhubarb, chestnut, nutgall and clove and ellagitannin from myrobalans and oak.





**2. Condensed tannins** - These tannins are also called as phlobatannins or proanthocyanidins. They are related to flavonoid pigments and have the polymeric formula flavone-3-ol. On treatment with acids or enzymes these tannins are decomposed into red insoluble compounds called as phlobaphenes. With ferric chloride they produce green colour. On heating these tannins produce catechol, therefore they are also called as catechol tannins. The drugs which contain condensed tannins are cinchona bark, cinnamon bark, pale and black catechu, cocoa, kola seeds etc.



**Pseudotannins** - Pseudotannins are low molecular weight compounds and do not respond to Goldbeater's skin test. Examples of pseudotannins are catechins from cocoa and chlorogenic acid from nuxvomica and coffee.

**Extraction and Isolation of tannins** - The various types of the methods of extraction depending upon the source of tannins are employed. As the tannins are high molecular weight compounds so it becomes difficult to isolate the tannins in pure form. Thus the solvents used are the mixture of polar, non-polar and semi polar solvent like alcohol, ether, water, acetone etc.

### IDENTIFICATION TESTS

- 1. Goldbeater's skin test** - The Goldbeater's skin\* (a membrane prepared from the intestine of ox) is soaked in hydrochloric acid. Then it is rinsed with distilled water and is added to the tannin solution (sample) for 5 minutes. It is washed with distilled water and transferred to 1% ferrous sulphate solution. A brown or black colour on the skin confirms the presence of tannins.
- 2. Phenazone test** - 10ml of aqueous extract of tannins is prepared and 1g of sodium acid phosphate is added. Warm it, cool and filter it. To the filtrate 2% phenazone solution is added. All the tannins present are precipitated.
- 3. Gelatin test** - To the solution of tannins add 1% gelatin solution containing 10% sodium chloride. The precipitate obtained confirms the presence of true tannins and pseudotannins.
- 4. Test with ferric chloride** - To the solution of tannins add ferric chloride solution. A blue, black, violet or green precipitate or colour confirms the presence of tannins.
- 5. Match-Stick test** - Dip a match stick in plant extract and dry it. Moisten it with conc. Hcl and warm near the flame. The wood of match stick turns to pink or red in colour which confirms the presence of tannins. (On heating tannins with conc. Hcl produce phloroglucinol. Further phloroglucinol reacts with the lignin of wood and produce pink colour.)



## VOLATILE OILS

Volatile oils are defined as **"the odorous and volatile constituents of plant and animal species"**. Volatile oils are also termed as 'etheral oils' because they evaporate when exposed to air at an ordinary temperature. They are also called as 'essential oils' as they are the essences or active constituents of the plant. Chemically they are derived from hydrocarbons and their oxygenated derivatives. They are composed of terpenes, monoterpenes ( $C_{10}H_{16}$ ), sesquiterpenes ( $C_{15}H_{24}$ ), diterpenes ( $C_{20}H_{32}$ ), polyterpenes ( $(C_5H_8)_n$ ) and their derivatives.

Volatile oils are present in the entire plant or any part of the plant such as bark, fruit, leaf, root, rhizome, wood and seed etc. They are secreted in the schizogenous or lysigenous glands, ducts and glandular trichomes. Volatile oils are formed by hydrolysis of some glycosides and by the protoplasm directly. They are present in plants belonging to family like Umbelliferae, Rutaceae, Lauraceae, Zingiberaceae, Piperaceae and Labiatae etc. Volatile oils are widely used as spices and flavouring agent. They are used in perfumery and cosmetic industries. They are also used as carminative, antiseptic, antispasmodic and antimicrobial.

Terpeneless volatile oil – When terpenes are removed from volatile oils they are termed as terpeneless volatile oils. They possess good flavouring properties so they are used in cosmetics and perfumeries.

### PROPERTIES

- (i) Majority of volatile oils possess a characteristic odour which differs from one specimen to another.
- (ii) Volatile oils evaporate completely at room temperature and do not leave spot on paper.
- (iii) The specific gravity of volatile oils is less than 1 and are lighter than water. But there are few exceptions whose specific gravity is more than one such as oil of cinnamon, oil of garlic, oil of clove and oil of cherry laurel.
- (iv) They possess high refractive indices.
- (v) Volatile oils are optically active.
- (vi) Volatile oils are insoluble in water but soluble in alcohol, chloroform, ether, acetone and carbon disulphide etc.
- (vii) On storage, due to oxidation and resinification of volatile oils they become dark in colour.



**Classification** - The volatile oils and volatile oil containing drugs are classified as follows -

Class	Examples of drug
Hydrocarbon volatile oils	Turpentine, Black pepper.
Aldehyde volatile oils	Cinnamon, Cassia, Lemon grass, Lemon peel, Bitter almond, Bitter orange peel.
Alcohol volatile oils	Peppermint, Coriander, Sandalwood, Citronella oil.
Ketone volatile oils	Dill, Caraway, Cumin, Camphor, Jatamansi, Buchu, Musk, Spearmint.
Phenol volatile oils	Clove, Tulsi, Thyme, Ajowan.
Phenolic ether volatile oils	Fennel, Anise, Calamus, Nutmeg.
Oxide volatile oils	Eucalyptus, Chenopodium, Cardamom.
Ester volatile oils	Valerian, Garlic, Lavender.

**Extraction** - The volatile oils are extracted by the following methods -

1. Distillation
2. Expression
3. Extraction

**1. Distillation** - Three different techniques of distillation are used -

**(i) Water distillation** - It is a common method in which water is used to extract the volatile oils from herbal drugs. It is employed for those drugs whose constituents do not degrade by boiling up to 100°C.

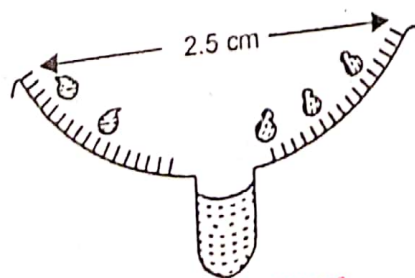
**(ii) Water and Steam distillation** - It is generally employed to those drugs whose constituents undergo degradation by direct boiling.

**(iii) Steam distillation** - It is generally used for the fresh drugs which contains moisture and do not require maceration.

**2. Expression** - There are various drugs in which the volatile oil present decomposes when they are subjected to distillation. Therefore the volatile oil present in the rind of fruits like lemon peel and orange peel can be obtained by method of expression (i.e. by application of pressure). The major advantage of this method is that the natural fragrance of the drug is preserved. The various expression methods used are -

**(i) Sponge method** - The rind of the citrus fruits such as orange, bergamot and lemon is separated and squeezed so that the secretory glands rupture. The volatile oil which oozes out is collected by the sponge and subsequently the sponge is squeezed in a vessel. Further the oil is separated.

**(ii) Ecuelle a Piquer** - Ecuelle a Piquer is a bowl like apparatus and its inner layer consists of pointed metal needles which are long enough to penetrate the epidermis of the fruits. The fruits such as lemon are placed in the bowl and rotated continuously until oil glands are punctured and discharge the oil. The oil is collected and further decanted and filtered.





(iii) **Mechanical method** - Now days the various volatile oils are extracted by different mechanical methods which work on the above principles. No doubt the output of the oil has been increased by using these methods.

3. **Extraction** - This method is employed for those drugs which contain very less amount of volatile oil or the constituents of oil may decompose due to exposure to steam e.g. volatile oil obtained from jasmine flowers, narcissus flowers and gardenia flowers etc. The extraction can be done by following two methods -

(i) **Extraction with volatile solvents** - The drug is extracted with low boiling volatile solvent like benzene, ether, n-hexane etc either by hot continuous percolation or by percolation. The advantage of this method is that the uniform temperature can be maintained during extraction which helps in preserving the natural fragrance.

(ii) **Extraction with non-volatile solvents** - Generally this procedure is used to prepare high quality of perfume oil. The volatile oil present in the flower petals is extracted by this method as it is not feasible to remove the volatile oil by any other method. Commonly three methods are employed:-

(A) **Enfleurage method** - In this method a layer of fat is applied on the glass plates which are arranged in wooden frame. The drug (fresh flower petals) is spread on the glass plate and allowed to imbibe in the fat for 24hrs after which the exhausted petals are removed and replaced by fresh flower petals. This process is carried out till the fatty material is saturated with essential oil. The saturated fatty material (known as pomade) is then extracted with alcohol to separate the volatile oil.

(B) **Pneumatic method** - In this, the warm air is passed through the flowers which help in loading of volatile oil particles in the air. This loaded air is passed through a fine spray of melted fat in a closed chamber wherein the volatile oils gets absorbed.

(C) **Maceration** - The fresh flower petals are gently heated with melted fat with continuous stirring. The flowers are strained and squeezed and the fat is allowed to cool. The fat is extracted continuously three times with alcohol to separate the volatile oil.

## IDENTIFICATION TEST

Volatile oils can be identified by physical tests (colour, odour, boiling point, optical rotation and refractive index) and specific chemical tests which are mentioned in individual drugs.

**Storage** - Volatile oils should be stored in well closed, well filled containers away from light and in cool place.

## (B) RESINS AND RESIN COMBINATIONS

Resins are defined as "**the amorphous non nitrogenous products of complex chemical nature**". Resins are the mixture of essential oil, oxygenated products of terpenes and carboxylic acids. They are the exudation products from the trunk of various trees. Resins are formed in schizogenous or schizolysigenous ducts or cavities of the plant. When the resins are produced as a normal product of metabolism without injury to the plant they are termed as normal or physiological resin like resins of pinus. If the resins are produced by injury or wound to the plant they are called as abnormal or pathological resin like benzoin and tolu balsam. Resins are present in different parts of the plant such as roots, rhizomes,



fruits, seeds, trunk, flowers and fruiting tops etc. Chemically resins contain resin acids, resin phenol, resin alcohol, esters and inert substances. They are normally used as antiseptics, carminative, purgative, expectorant and analgesic etc. Resins are also obtained from animals e.g. shellac.

## PROPERTIES

- (i) Resins are transparent or translucent solids, semisolid or liquid substances.
- (ii) They are insoluble in water but soluble in organic solvents like alcohol, fixed oil, volatile oil and chloral hydrate solution.
- (iii) They burn with smoky flame as they contain large number of carbon atoms.
- (iv) On heating they soften and finally melt.
- (v) Resins have specific gravity more than one and are heavier than water.
- (vi) On storage, they darken in colour.

**Classification** - Resins are classified into two categories as mentioned below:-

**1. Chemical classification** - The resins are classified on the basis of chemical constituents such as-

- (i) **Acid resin** - These contain a large portion of carboxylic acid and phenols. They combine with alkali and their metallic salts are termed as resinates. With aqueous solution of alkali they form soap-like solution or colloidal suspension. Various examples of resin acids are abietic acid (colophony), copaivic acid and oxycopaivic acid (copiba), primaric acid (fankicense) and commiphoric acid (myrrh) etc.
- (ii) **Resin alcohol** - Resin alcohols are also called as ressinols. They have high molecular weight and occur in both i.e. free form and combined form. Ressinols are tetracyclic or pentacyclic alcohols and are normally a-amyrine and b-amyrine derivatives. They do not give positive test with iron salts. Examples are like benzoeresinol from benzoin, gurjuresinol from gurjun balsam and storesinol from storax.
- (iii) **Resin phenol** - Resin phenols are also called as resinotannols. They also have high molecular weight and occur in both i.e. free form and combined form. The phenolic group of tannins is combined with resins acid. They give positive test with iron salts. Examples are like peruresinotannol from balsam of peru, toluressinotannols from balsam of tolu and siaressinotannol from sumatra benzoin.
- (iv) **Ester Resins** - These are the esters of resin alcohol or resinotannol combined with resin acid or balsamic acid. Examples are cinnamyl cinnamate from storax and benzyl benzoate from benzoin.
- (v) **Resenes** - These are the neutral and inert substances as they do not contain characteristic functional group. They do not show any specific chemical properties. They do not form salts or esters and are not hydrolyzed by alkalies. They have high molecular weight. The drugs which contain resenes are asafetida, gutta purcha and colophony.
- (vi) **Glycoresins** - These contain the glycosidal resins. Glycoresins on hydrolysis yields sugar and complex acids, e.g. is jalap resin from jalap.

**2. Constituents of Resins** - Resins are also classified on the basis of major constituents present either in resin or resin combination. The homogenous combination of resins with other plant products is called as resin combinations.



- (i) Acid resin – This is discussed under chemical classification.
- (ii) Oleo-resin – When there is a homogenous mixture of resin and volatile oil it is termed as oleo-resin like capsacin, ginger and copaiba.
- (iii) Oleo-gum-resin – These are the homogenous mixture of resin, gum and volatile oil like asafoetida, myrrh, and turmeric.
- (iv) Gum resins – These are the homogenous mixture of gum and resin, e.g. gamboge.
- (v) Balsams – Balsams contain benzoic acid or cinnamic acid or both. Examples are benzoin, storax and tolu balsam.

**Extraction and Isolation** – Resins can be extracted from plants and animals by any one method of the following:-

- (i) By extraction with alcohol and then precipitating with water, e.g. ipomoea, and jalap.
- (ii) As plant exudates by injury or incisions, e.g. asafoetida, myrrh etc.
- (iii) By heating the plant part e.g. guaiacum.
- (iv) By distillation method e.g. colophony
- (v) By various treatment of the excretions obtained from animal e.g. shellac.

**Identification Test** – Resins can be identified by physical test and specific chemical test which are mentioned in individual drugs.

### SUGGESTED READINGS

Brossi A and Cordell G.A., "The Alkaloids" Vol. 41, Academic Press Inc San Diego.  
 Sim S.K. "Medicinal Plant Glycosides" University of Toronto Publications.  
 Harborne J.B. "Biochemistry of Phanolic Compounds" Academic Press, New ork.  
 Pridham J.B., "Terpenoids in Plants" Academic Press New York.

## QUESTION BANK

### SHORT ANSWER QUESTIONS

- Q.1. Define Alkaloids. Explain their properties & functions.
- Q.2. Discuss the classification of Alkaloids.
- Q.3. Define Glycosides. Explain their properties.
- Q.4. Discuss the isolation of Glycosides.
- Q.5. Define Resins. Explain their properties.
- Q.6. Discuss the classification of Resins.
- Q.7. Define Volatile oils. Discuss their properties.
- Q.8. Explain the various extraction procedure of volatile oils.
- Q.9. Define Tannins & Explain their properties.
- Q.10. Discuss the classification of Tannins.
- Q.11. Explain the identification tests of Tannins.