PHYTOCHEMICAL

The term “phytochemical” is derived from Greek word or Plant (Phyto), denoting their origin from plants.

The processes generating phytochemicals have been separated into primary and secondary metabolism. Although primary and secondary metabolisms are interrelated, the primary processes result in formation of sugars and protein biosynthesis, while the secondary constituents are produced in plants through three main routes,

i. Acetate malonate
ii. Acetate mevalonate and
iii. Shikmic acid pathways

These pathways are everywhere and the first products found in quantity may be considered primary metabolites. Thus, palmitic acid is the primary metabolite of the acetate-malonate pathway, whereas other fatty acids and their derivatives being considered as secondary metabolites.

PRIMARY METABOLITES

Therapeutically Inactive Constituents

The plants produce certain inert substances that include cellulose, lignin, suberin and cutin.

Moreover starch, albumin, pigments and many other compounds which may not have definite pharmacological activity are considered as inert constituents.

SECONDARY METABOLITES

Therapeutically active constituents

There may be either single chemical substance or mixtures of principles.

They are formed from primary processes and plant utilize them for usually protection and transportation.

They are formed from biosynthetic pathways and are known as secondary metabolites, having many useful therapeutic functions.

These diverse compounds can be exemplified by alkaloids, glycosides, terpenoids, steroids phenylpropanoids, and peptides.

Further the mixtures include gums, resins and resin combinations (e.g. oleogum resin), volatile oils, fixed oils, fats and waxes.

All types of compounds are eventually degraded and enter the various metabolic pools or are completely oxidized to carbon dioxide, e.g. flavonoids and phenolic compounds are degraded to aliphatic acids, terpenoids to isoprenoid units and alkaloids to amino acids.

They are not in general storage compounds.

ALKALOIDS

INTRODUCTION:

Extremely difficult to define because they do not represent a homogenous group of compounds from chemical, biochemical or physiological viewpoint.

Occur in about 15% of all vascular terrestrial plants

ALKALOIDS

HISTORY:

Alkaloid /Pflanzenkalien given by Meissner-German P'cist-1819.
1803- Narcotine- Derosne and morphine-serturner
1817-1819 Emetine & Colchicine-Pelletier and caventon
No. of alkaloids discovered till today more than 6000.

DEFINATION:

Organic products of natural or synthetic orign, Basic in nature having One or more nitrogen atoms Normally of heterocyclic nature, Possess specific physiological actions on human or animal body-used in small quantity.

TRUE ALKALOIDS:

Toxic, heterocyclic nitrogen derived from amino acids –basic in nature-all characteristics of alkaloids

PROTO ALKALOIDS:

Simple amine-nitrogen is not in heterocyclic ring-biological amines

PSEUDO ALKALOIDS:

Not derived from A.A., don't show typical characters, gives standard qualitative test for alkaloids. e.g. conessine, caffeine

DISTRIBUTION:

Plants- reach sources of alkaloid, found in fungi, animal, bacteria
Practically- reproduced in laboratory by chemical synthesis.
Have restricted distribution in certain families and genera
Based on incomplete investigation of plants up to present
Leguminosae, Papaveraceae, Ranunculaceae, Rubiaceae, Solanaceae, and Berberidaceae outstanding yielding plants
Amaryllidaceae and liliaceae- 2 promising family
Labitae and rosaceae-free from alkaloids
Monocot- does not generally produce alkaloids
Various parts of plants- seed, fruit, leaves, stems, roots, rhizomes and roots, bark and fungi

PHYSICAL PROPERTIES:

Colorless, crystalline solid with sharp melting point
Some are amorphous gums, liquid & volatile in nature
Free alkaloids-soluble in org., non-polar, immiscible solvent
Free bases- Insoluble in water
Salts of most alkaloids- soluble in water
Salts of free bases- vary sparingly soluble in org. solvent
Solubility useful in pharmaceutical industries for extraction and formulation of final p'ceuticals preparation

CHEMICAL PROPERTIES

Basic in reaction, due to availability of lone pair of ē on N.

Basicity-changed due to adjacent group - ē releasing/ withdrawing.

Basic characters are very much sensitive to decomposition –cause a problem during their storage.

Salt formation with an inorganic acid prevents many a time their decomposition.

Exists in form of 1° amine-R-NH2-mescaline

2° amine-R2-NH- ephedrine

3° amine-R3-N-atropine

4° amine-$R4N^{+}X^{-}$ –tubocurarine

CHEMICAL TESTS:

Alkaloidal precipitating reagents:

Mayer's reagent- Potassium Mercuric iodide-**cream ppts**

Dragendorff's reagent- potassium Bismuth Iodide-**Reddish brown ppts**

Wagner's Reagent- Iodine Potassium Iodide - **Reddish Brown ppts**

Hager's reagent- picric acid solution-**Yellow ppts**

Alkaloidal colouring agents:

Marquis reagent (Formaldehyde sulfuric acid)

Mandalin's reagent (Sulphovanadic acid)

Erdmann's reagent (nitric acid-sulfuric acid)

Some alkaloids do not respond to the aformentioned tests and these can be detected by specific chemical tests, e.g. Caffeine when treated with HCl and heated, residue after evaporation upon exposing to ammonia gives purplish red colour (Murexide test).

Ergot alkaloids-Van Urk reagent

Tropane alkaloids-Vitali Morine colour reaction

CLASSIFICATION OF ALKALOIDS:

PHARMACOLOGICAL

- Depending on physiological response
- CNS stimulant/depressant, sym. mimetics, analgesic
- Does not take into account the chemical nature of drug
- Within same drug the individual alk. May exhibit diff action. Morphine-narcotic, codeine-antitussive

TAXONOMICAL

- Classify the vast no. of alkaloids
- Based on their distribution in various plant families e.g. solanaceae, papilionaceous alkaloids
- Grouped according to the name of genus in which they occur e.g. ephedra, cinchona alk.

BIOSYNTHETIC

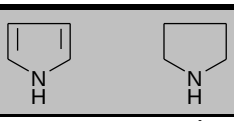
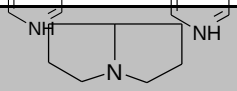
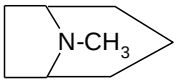
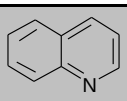
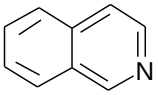
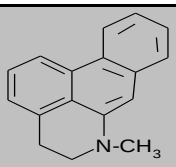
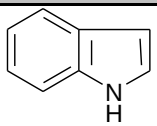
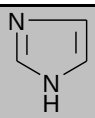
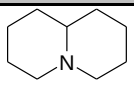
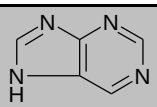
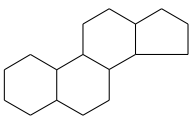
- Gives significance to the precursor

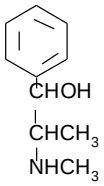
- Variety of alkaloids with diff taxonomic distribution and physiological activities can be brought under same group if they derived from same precursor

CHEMICAL

- Most accepted way of classification
- Based on type of fundamental (heterocyclic) ring str.

True alkaloids

TYPE	BASIC RING STR	EXAMPLES
PYRROLE-PYRROLIDINE		**Cocoa species**
Pyridine & Piperidine		**Arecoline, Lobeline, coniine**
Pyrrolizidine		**Echimidine, senecionine**
Tropane		**Atropine hyoscymine, hyoscine**
Quinoline		**Quinine, cinchonine**
Isoquinoline		**Morphine, codeine**
Aporphine (reduced isoquinoline naphthalene)		**Boldine**
Indole (benz pyrrole)		**Ergometrine, ergotamine, reserpine, vincristine**
Imidazole		**Pilocarpine**
Norlupinane		**Cytisine, lupanine**
Purine (Pyrimidine/Imidazole)		**Caffiene, theobromine, theophylline**
Steroidal (cyclopentano perhydro phenanthrene ring)		**Protoveratine, solanidine, conessine**
Diterpene	**C20H32**	**Aconite, aconine,**

		hypoaconitine
Alkylamine (amino alk)		**Ephedrine, pseudoephedrine**

Names of alkaloids are obtained in various ways:

From the generic name of plant yielding them -Atropine

From the specific name of plant yielding them-Cocaine

From the common name of plant yielding them- Ergotamine

From the physiologic activity-Emetine

Occasionally from the discoverer-Pelletierine

ROLE OF ALKALOIDS IN PLANTS:

Synthesized by a particular, stereo specific, many time complicated and energy consuming pathways & further they r metabolized to other alkaloidal or non-alkaloidal substances.

1. Reserve sub. with an ability to supply Nitrogen
2. Defensive mechanism for plants growing in dry regions to protect from grazing animals, herbivores & insects
3. End products of detoxification mechanism in plants & by this way check formation of substances which may prove to be harmful to the plants
4. Possible role as regulatory growth factors in plant
5. Present normally in conjugation with plant acids, like meconic acid, cinchotannic acid etc. therefore, alkaloid could be acting as carriers within plants for transportation of such acids.

Pharmacological actions:

Analgesics & narcotics, central stimulants, mydriatics, rise and fall in B. P., anticancer

Biosynthesis:

Many alkaloids structures-rationalized through simple chemical reactions that involve amino acids

Most alkaloid Precursors- Phenylalanine, tyrosine, tryptophane, histidine, anthranilic acid, lysine and ornithine.