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ALKALOIDS

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Alkaloids are basic nitrogen containing compounds obtained from plants, animals & microorganisms having a marked physiological action

Characteristics:

Well defined crystalline substances, generally occurring as solids except nicotine which is a liquid, colourless except berberine which is a yellow coloured alkaloid. Occur in plants in the salt form.

They answer the following chemical tests:

1. mayer's reagent- (potassium mercuric iodide)
cream coloured precipitate
2. wagner's reagent- (iodine in potassium iodide)
reddish brown precipitate
3. hager's reagent- (salt solution of picric acid)
yellow precipitate
4. dragendorf's reagent- (potassium bismuth iodide)
reddish brown precipitate

Caffeine is a pseudo alkaloid drug which does not answer this test

Extraction: The powdered drug is defatted using petroleum ether if necessary
The powder is further basified using lime to break the salt form of the alkaloid & liberate free base which can be extracted using an organic solvent
Alkaloidal salts can be directly extracted using an acidified aqueous solvent

Classification:

1. pharmacological method
2. taxonomic method
3. biosynthetic method
4. chemical method – true & proto alkaloids
 - TRUE ALKALOIDS
 1. Pyrrole & pyrrolidine eg- coca
 2. pyridine & piperidine eg- coniine
 3. tropane eg- atropine
 4. quinoline eg- cinchona
 5. indole eg- rauwolfia
 6. purine eg- caffeine
 7. steroidal eg- kurchi
 8. isoquinoline eg- opium

- PROTO ALKALOIDS
eg- ephedrine

INDOLE ALKALOIDS

ERGOT / ARGOT / ST. ANTHONY'S FIRE

BIOLOGICAL SOURCE: sclerotium of fungus *claviceps purpurea*, at the ovary of rye plant *secale cereale*

Family: graminae (fungus belongs to family *clavicipitaceae*)

GEOGRAPHICAL SOURCE: Switzerland

Known to have caused gangrene (ergotism) in Germany

Life cycle:

1. sexual / sphaerial stage
2. asexual / sclerotium stage

Sexual stage:

The ascospores infect the ovary of the rye plant & if conditions are favourable it develops hyphal strands

It forms a white mass over the ovary known as the mycelium

Asexual stage:

The hyphal strands further develop invading the ovary & converting it to a hard violet sclerotium

Sclerotium contains stromatum which shows a globular stalk

It encloses bag like structures known as ascus containing ascospores

If these ascospores are liberated they infect another rye plant

Morphology of sclerotium:

Hard, violet, odourless, with an unpleasant taste

Chemistry:

Derivatives of lysergic acid

Water soluble ones are ergometrine & ergometrinine

Water insoluble ones are ergotamine & ergotoxine

Only the levo isomer is active

Uses:

Ergometrine is an oxytocic drug but its methyl derivative is preferred as it causes less hypertension

Ergotamine is analgesic in migraine

Chemical Test:

1. gives a blue colour with Van Curk's reagent (para dimethyl amino benzaldehyde)
2. gives blue fluorescence in water
3. when treated with ether, H₂SO₄ followed by sodium bicarbonate, aqueous layer shows a red violet colour
4. ergotamine + glacial acetic acid + ethyl acetate + H₂SO₄ gives a blue solution with a red tinge. When further treated with FeCl₃ the blue colour disappears

VINCA / PERIWINKLE

BIOLOGICAL SOURCE: aerial parts of catharanthus roseus

Family: apocynaceae

GEOGRAPHICAL SOURCE: India, Madagascar

Morphology:

Leaves are small, opaque, dark green, odourless & bitter to taste

Chemistry:

Indole alkaloids such as vinblastine, vincristine, ajamlicine & serpentine

Use:

Potent anti cancer agent, hypotensive & anti diabetic

NUXVOMICA

BIOLOGICAL SOURCE: dried seeds of strychnos nuxvomica

Family: loganiaceae

GEOGRAPHICAL SOURCE: srilanka, India

Morphology:

Seeds are circular, flat, grayish green, covered with trichomes & extremely bitter to taste

Chemistry:

Contains two main indole alkaloids strychnine & brucine

Use:

Rarely used as a nerve tonic as it is poisonous in large doses

Chemical Test:

1. section when treated with concentrated HNO₃ shows a yellow colour with brucine
2. section when treated with ammonium vanadate & H₂SO₄ shows a purple colour with strychnine
3. strychnine when treated with H₂SO₄ & K₂Cr₂O₇ develops a violet to yellow colour

RAUWOLFIA / SARPAGANDHA

BIOLOGICAL SOURCE: dried roots of rauwolfia serpentina

Family: apocynaceae

GEOGRAPHICAL SOURCE: asia, America

Morphology:

Snake shaped, brown coloured, longitudinal wrinkles tapering towards the end

Chemistry:

Reserpine, ajamlicine, serpentine

Use:

Antihypertensive by preventing uptake of adrenaline

Chemical Test:

1. freshly fractured surface of the root when treated with concentrated HNO₃ shows red coloured medullary rays
2. reserpine gives a violet colour with vanillin in acetic acid

TROPANE ALKALOIDS

BELLADONA

BIOLOGICAL SOURCE: dried leaves of atropa belladonna

Family: solanaceae

GEOGRAPHICAL SOURCE: England, Europe, India

Morphology:

Leaves are greenish brown, ovate in shape with an entire margin & bitter to taste

Microscopic Characters:

Dorsiventral leaf

Collenchyma above & below the mid rib

Unicellular covering trichomes, unicellular glandular trichomes

Microsphaenoidal calcium oxalate crystals

Chemistry:

Atropine, hyoscyanine, belladonine

Use:

Atropine is a parasympatholytic, thus decreases secretion & spasms

Chemical Test:

Vitali morin test – to the drug fuming nitric acid is added & it is evaporated to dryness.

Methanolic KOH is added to the acetone solution of the nitrated residue

It develops a violet colour

STRAMONIUM

BIOLOGICAL SOURCE: dried leaves & flowering tops of datura stramonium

Family: solanaceae

GEOGRAPHICAL SOURCE: America, france

Morphology:

Leaves are grayish green with a crenate margin & unequal base

Microscopic Characters:

Dorsiventral leaf

Collenchyma above & below the mid rib

Unicellular covering & glandular trichomes

Xylem surrounded by phloem

Anisocytic stomata

Chemistry:

Hyoscine, atropine, belladonine

Use:

Hyoscine is an anti emetic

Chemical Test:

Vitali morin test

COCA LEAVES

BIOLOGICAL SOURCE: dried leaves of erythroxyton coca (bolivian variety)

Erythroxyton truxillense (Peruvian variety)

Family: erythroxytonaceae

GEOGRAPHICAL SOURCE: Bolivia, peru

Morphology:

Peruvian leaves are pale green, fragile, thin, elliptical in shape

Bolivian leaves are greenish brown, oval in a shape with a prominent mid rib

Microscopic Characters:

Dorsiventral leaf

Collenchyma above & below mid rib

Xylem surrounded by phloem & pericyclic fibres

Paracytic stomata

Chemistry:

Cocaine, cinnamoyl cocaine, tropocaine, benzoylecgonine

Extraction:

The leaf powder is basified with lime & extracted using an organic solvent

The free bases are converted to their hydrochlorides by using HCl

Due to this procedure cocaine liberates ecgonine, methanol & benzoic acid whereas cinnamoyl cocaine generates ecgonine, methanol & cinnamic acid

The ecgonine thus obtained is used to synthesize cocaine by treating it with benzoic anhydride, methyl iodide, methanol & sodium methoxide

Use:

Local anaesthetic

Chemical Test:

Drug powder when heated with concentrated H₂SO₄ gives a typical odour of methyl benzoate

QUINAZOLINE ALKALOIDS

VASAKA LEAF / ADULSA

BIOLOGICAL SOURCE: dried & fresh leaves of *adhatoda vasica*

Family: *acanthaceae*

GEOGRAPHICAL SOURCE: India

Morphology:

Leaves are dark green, lanceolate in shape, have a crenate margin with a characteristic odour & bitter taste

Chemistry:

Vasicine, vasicinone & adhatodic acid

Uses:

Vasicine is an expectorant. It gets oxidized to vasicinone which is an abortifacient in large doses, otherwise a bronchodilator

PYRIDINE ALKALOIDS

LOBELIA HERB / INDIAN TOBACCO / ASTHMA WEED

BIOLOGICAL SOURCE: dried aerial parts of *lobelia nicotianefolia*

Family: *campanulaceae*

GEOGRAPHICAL SOURCE: India

Morphology:

Leaves are sessile, large, dark green & possess an acrid taste

Chemistry:

Lobeline, lobelidine & isolobanine

Use:

Respiratory stimulant

Chemical Test:

1. lobeline solution if heated gives typical odour of acetophenone
2. lobeline in H₂SO₄ when treated with formaldehyde develops red colour

IMIDAZOLE ALKALOIDS

PILOCARPUS

BIOLOGICAL SOURCE: dried leaves of pilocarpus jaborandi
Pilocarpus microphyllus

Family: rutaceae

GEOGRAPHICAL SOURCE: south America

Morphology:

Leaves are greyish green with an asymmetrical base & possesses aromatic odour & bitter taste

Chemistry:

Contains pilocarpine, pseudopilocarpine, pilosine & limonene

Uses:

Antagonist to atropine, causes miosis, increases salivation & sweating

Chemical Test:

Pilocarpine solution when treated with H₂SO₄, H₂O₂, benzene & K₂Cr₂O₄, the organic layer appears bluish violet in colour whereas aqueous layer shows yellow colour

INDOLE ALKALOIDS

CALABAR BEANS

BIOLOGICAL SOURCE: dried type seeds of physostigma venenosum

Family: leguminosae

GEOGRAPHICAL SOURCE: Africa

Morphology:

Reddish brown in colour, hard, shiny & rough to touch

Chemistry:

Contains physostigmine, starch & proteins

Use:

Helps in contraction of pupil, retards respiration & causes bradycardia

OPIUM / POPPY PLANT

BIOLOGICAL SOURCE: dried latex obtained from capsules of papaver somniferum

Family: papaveraceae

GEOGRAPHICAL SOURCE: India (MP), turkey, Pakistan, Afghanistan

Collection:

Collection is started when capsules change colour from dark green to yellowish green.

Longitudinal incisions about 2mm deep are given on the capsules to exude the latex

The latex is allowed to solidify overnight & later scraped off

The process is repeated 4 times with a gap of 2 days

Morphology:

The dried latex is dark brown, extremely bitter to taste & has a strong odour

Chemistry:

Contains phenanthrene type of alkaloids such as morphine & codeine & benzyl isoquinoline type of alkaloids such as papaverine & noscapine

These occur as salts of meconic acid

Use:

Morphine is a narcotic analgesic & stimulant

Codeine is an anti tussive

Papaverine is a smooth muscle relaxant

Chemical Test:

1. aqueous solution of meconic acid shows a deep reddish purple colour with ferric chloride
2. morphine when sprinkled with concentrated HNO₃ shows an orange red colour. This is not allowed by codeine
3. morphine solution when treated with ferric chloride & potassium ferricyanide gives a bluish green colour
4. papaverine solution in HCl & potassium ferricyanide develops a lemon yellow colour

Varieties of opium:

Indian, Turkish, Persian, European, manipulated Persian & European

QUINOLINE AKALOIDS

CINCHONA BARK / JESUIT'S BARK / PERUVIAN BARK

BIOLOGICAL SOURCE: dried bark of cultivated trees of cinchona calisaya

Cinchona officinalis

Cinchona ledgeriana

Cinchona succirubra

Family: rubiaceae

GEOGRAPHICAL SOURCE: India, Bolivia, srilanka

Collection:

It is collected by coppicing method

Vertical incisions are made on branches, trunk of the tree & these incisions are connected by horizontal circles

The bark is then stripped off & dried in sunlight & further by artificial heat (175 degree F)

The root bark is collected by uprooting trees & separating manually

Morphology:

Stem bark is rough with transverse fissures

Outer surface is grey & inner surface is pale yellowish brown to deep reddish brown

Root bark is curved, outer surface is scaly, outer & inner surface with same colour

Microscopic Characters:

Cork cells are thin walled

Cortex has phloem fibres

Medullary rays with radially arranged cells

Idioblast of calcium oxalate is a specific characteristic
Starch grains in parenchymatous tissues
Stone cells rarely present

Chemistry:

Contains quinine, quinidine, cinchonine & cinchonidine
Also contains quinic acid & cinchotannic acid

Chemical Test:

1. on heating the drug in a dry test tube with glacial acetic acid, purple vapours are produced
2. thalleoquin test: drug + bromine water + dilute ammonia gives an emerald green colour
3. drug when treated with quinidine solution gives a white precipitate with silver nitrate which is soluble in nitric acid

Uses:

Anti malarial, anti pyretic, quinine is used in arrhythmias against atrial fibrillation

ISOQUINOLINE ALKALOIDS

IPECAC

BIOLOGICAL SOURCE: dried roots of cephalis ipecacuanha (brazilian / rio)
Cephalis acuminata (panama / cartagena)

Family: rubiaceae

GEOGRAPHICAL SOURCE: brazil, panama

Morphology:

Brazilian ipecac is dark brick red as compared to greyish brown panama ipecae
Both possess faint odour & bitter taste

Chemistry:

Brazilian – emetine:cephalin ratio is 4:1

Panama – emetine:cephalin ratio is 1:1

Uses:

Expectorant in mild doses & as an emetic in large doses
Emetine also possesses anti protozoal activity

Chemical Test:

1. emetine shows a bright green colour with H₂SO₄ & molybdic acid
2. emetine when shaken with water & small amount of HCl, filtered & to the filtrate potassium chlorate is added gives a yellow colour changing to red

PYRIDINE- PIPERIDINE ALKALOIDS

TOBACCO

BIOLOGICAL SOURCE: dried leaves of nicotiana tabacum

Family: solanaceae

GEOGRAPHICAL SOURCE: India, france

Morphology:

Leaves are large, green with a dentate margin

It has a characteristic strong odour & bitter taste

Chemistry:

Nicotine, nornicotine & anabasine

Use:

Stimulant

PROTO ALKALOIDS

EPHEDRA / MA HUANG

BIOLOGICAL SOURCE: dried stem of ephedra gerardiana

Family: ephedraceae / gnetaceae

GEOGRAPHICAL SOURCE: china, Pakistan

Morphology:

Greyish green, thin, cylindrical stem bearing scaly leaves & internodes

No typical odour but has a bitter taste

Chemistry:

Contains amino alkaloids like ephedrine, norephedrine & pseudo ephedrine

Uses:

Sympathomimetic & bronchodilator

Chemical Test:

Aqueous solution of ephedrine shows a violet colour when treated with dilute HCl & CuSO₄ followed by dilute NaOH

COLCHICUM / AUTUMN CROCUS

BIOLOGICAL SOURCE: dried seeds & corms of colchicum luteum

Family: liliaceae

GEOGRAPHICAL SOURCE: Europe

Morphology:

Seeds are hard, reddish brown, rough to touch whereas corms are yellowish in colour with a longitudinal groove & bitter to taste

Chemistry:

Contains amino alkaloid colchicine & demecolchicine

Uses:

Rheumatism, treatment of gout, anti tumour activity & polyploidy

ACONITE / BACHNAG

BIOLOGICAL SOURCE: dried roots of aconitum napellus

Family: ranunculaceae

GEOGRAPHICAL SOURCE: germany, spain

Morphology:

Roots are dark brown, longitudinally wrinkled & tapering towards one end

They have slight odour & taste

Chemistry:

Diterpene alkaloids such as aconitine, neopelline, neoline & small amount of ephedrine

Aconitine is an active constituent but if hydrolysed forms benzoyl aconine & aconine which are less active

Uses:

Externally in neuralgia & sciatica

PSEUDO ALKALOIDS

COFFEE

BIOLOGICAL SOURCE: dried seeds of coffee Arabica

Family: rubiaceae

GEOGRAPHICAL SOURCE: southern part of India, Indonesia

Collection:

The unripe coffee fruit is dark green & is collected when it turns red

Each fruit has two locules containing one seed each

The seeds are separated, roasted because of which they develop a dark brown colour & a typical odour

Chemistry:

Contains caffeine which is a salt of chlorogenic acid, volatile oil known as caffeol, enzymes & other phenolic compounds

Uses:

Stimulant, diuretic (due to theophylline), & source of caffeine

Chemical Test:

1. Murexide test: caffeine when heated with HCl & potassium chlorate gives a residue which turns purple when exposed to ammonia vapours
2. Caffeine forms a white precipitate with tannin solution

TEA

BIOLOGICAL SOURCE: prepared leaves of *thea sinensis*

Family: *theaceae*

GEOGRAPHICAL SOURCE: India, srilanka

Collection:

The tea plant is a small green shrub wherein younger leaves are picked & allowed to undergo fermentation

Polyphenol oxidase carries out oxidation to produce furfural & other phenolic compounds

The process imparts a dark brown or black colour & a typical odour of tea powder

For preparation of green tea, fresh leaves are dried & roasted in copper pans & finally powdered

Chemistry:

Contains caffeine, theophylline, theobromine, oxidase enzyme & tannins

Use:

Stimulant, diuretic, source of caffeine

Chemical Test:

Murexide test

KOLA NUTS / BISSY SEEDS

BIOLOGICAL SOURCE: seeds of *cola nitida*

Family: *sterculiaceae*

GEOGRAPHICAL SOURCE: west Africa, brazil

Morphology:

Seeds are plano convex in shape & reddish brown with a bitter taste

Chemistry:

Contains caffeine, theobromine & a red pigment known as kola catechin

Use:

Stimulant

COCOA SEEDS

BIOLOGICAL SOURCE: seeds of *theobroma cacao*

Family: *sterculiaceae*

Collection:

The fruits are ellipsoidal in shape with a white pulp & contain about 40 to 50 seeds

Fermentation is carried out in boxes for about 3 days at a temperature below 60 degree Celsius

The seeds acquire a different colour, taste & odour

Seeds are then roasted to evaporate the water

It also facilitates removal of the seed coat

Seeds are then powdered to obtain cocoa powder

Chemistry:
Caffeine. Theobromine, other phenolic compounds

Use:
Stimulant

STEROIDAL ALKALOIDS

KURCHI

BIOLOGICAL SOURCE: dried bark of holarrhena antidysenterica
Family: apocynaceae
GEOGRAPHICAL SOURCE: India

Chemistry:
Steroidal alkaloid conessine & norconessine

Use:
Amoebic dysentery

ASHWAGANDHA

BIOLOGICAL SOURCE: dried roots of withania somnifera
Family: solanaceae
GEOGRAPHICAL SOURCE: India, Afghanistan

Morphology:
Roots are cylindrical, buff coloured, have a characteristic odour & are tasteless

Microscopic Characters:
Outermost layer of cork cells followed by cortex
Vascular bundle consists of phloem parenchyma & xylem blocking the pith

Chemistry:
2 types of chemical constituents
1. steroidal lactones called withanolides like withaferine
2. alkaloids like withanine, somniferine, anaferine
Also contains alcohols known as somnitol & somnirol

Uses:
Sedative, hypnotic, hypotensive & immunomodulatory

PYRAZOLINE ALKALOIDS

PEPPER

BIOLOGICAL SOURCE: dried fruits of piper nigrum

Family: piperaceae

GEOGRAPHICAL SOURCE: south India, Indonesia

Morphology:

Fruits are green when unripe but turn dark black after drying

The dried fruits are wrinkled with an aromatic odour & pungent taste

Chemistry:

Alkaloid piperine is responsible for pungent taste along with piperetine, resins, volatile oils containing limonene & pinen responsible for the odour

Uses:

Bronchitis & gonorrhoea