

Secondary Metabolites with Properties and Identification Tests

Alkaloids & its Identification Tests

Definition

- Alkaloids are nitrogen-containing, basic organic compounds derived from amino acids.
- They have significant physiological effects on humans and animals.

Occurrence:

- Widely distributed in the plant kingdom; found in about 15-20% of higher plants. Also occur in fungi, bacteria, and animals (e.g., amphibians).

Distribution:

- **Families:** Solanaceae (e.g., atropine), Papaveraceae (e.g., morphine), Rubiaceae (e.g., quinine), and Apocynaceae.
- **Plant parts:** Often concentrated in roots, bark, seeds, and leaves.
- **Examples:** Morphine (*Papaver somniferum*), Nicotine (*Nicotiana tabacum*), Quinine (*Cinchona* spp.).

Examples

- Morphine (Opium poppy – *Papaver somniferum*)
- Quinine (Cinchona bark – *Cinchona officinalis*)
- Nicotine (Tobacco – *Nicotiana tabacum*)

Properties

- Mostly alkaline in nature.
- Soluble in organic solvents but sparingly soluble in water.
- Exhibit a bitter taste.
- Many alkaloids have pharmacological activity, e.g., analgesic, stimulant, or sedative effects.

Isolation:

- Typically extracted using acid-base extraction.
- Plant material is acidified to extract alkaloids in salt form, followed by basification to free base form, then extracted with organic solvents.

Therapeutic Activity:

- Analgesic, antimalarial, antihypertensive, antitumor, CNS effects.

Pharmaceutical Applications:

- **Morphine** – Painkiller
- **Quinine** – Antimalarial
- **Atropine** – Anticholinergic
- **Vincristine/Vinblastine** – Anticancer
- **Ephedrine** – Bronchodilator

Tests for Identification of Alkaloids



1. Dragendorff's Test:

- Reagent: Potassium bismuth iodide solution.
- Positive Result: **Orange or reddish-brown precipitate** indicates the presence of alkaloids.

2. Mayer's Test:

- Reagent: Potassium mercuric iodide solution.
- Positive Result: **Cream-colored precipitate** formation.

3. Wagner's Test:

- Reagent: Iodine in potassium iodide solution.
- Positive Result: **Reddish-brown precipitate**.

Terpenoids

Definition:

- Terpenoids are modified terpenes, composed of isoprene units (C_5H_8) and contain additional functional groups such as oxygen.
- They are found in essential oils and are responsible for the aroma, color, and medicinal properties of many plants.

Occurrence:

- Abundant in all plant groups; also present in some animals and microorganisms.

Distribution:

- **Classes:** Monoterpenes, sesquiterpenes, diterpenes, triterpenes, and tetraterpenes.

- **Plant parts:** Found in resins, essential oils, flowers, leaves, and fruits.
- **Examples:** Menthol (*Mentha* spp.), Artemisinin (*Artemisia annua*), Taxol (*Taxus brevifolia*).

Examples:

- **Menthol** (from Peppermint – *Mentha arvensis*)
- **Artemisinin** (from Sweet Wormwood – *Artemisia annua*)
- **Taxol (Paclitaxel)** (from Pacific Yew – *Taxus brevifolia*)
- **Limonene** (from Citrus peel – *Citrus* spp.)

Properties:

- Mostly **lipophilic** and **volatile** (especially monoterpenoids).
- Often have **aromatic/fragrant odors**.
- **Soluble in organic solvents** (e.g., ethanol, ether), sparingly soluble in water.
- Can be **thermolabile** (sensitive to heat and light).
- Exhibit a wide range of **biological activities** such as antimicrobial and anti-inflammatory effects.

Isolation:

- Typically extracted by **steam distillation**, **solvent extraction**, or **supercritical CO₂ extraction**.
- Non-volatile terpenoids are extracted using **organic solvents** (e.g., hexane, ethyl acetate) and purified using chromatography.

Therapeutic Activity:

- **Antimalarial** (e.g., artemisinin)
- **Anticancer** (e.g., taxol)
- **Anti-inflammatory** (e.g., boswellic acid)
- **Antimicrobial, antioxidant, sedative, and bronchodilator** properties

Pharmaceutical Applications:

- **Artemisinin** – Treatment for malaria
- **Taxol (Paclitaxel)** – Used in chemotherapy for breast, ovarian, and lung cancers
- **Menthol** – Used in topical analgesics and decongestants
- **Camphor** – Used as a counterirritant and stimulant in balms and ointments
- **Limonene** – Used in aromatherapy and as a flavoring agent

Tests for Identification of Terpenoids:

1. Salkowski Test

- **Reagent:** Concentrated sulfuric acid
- **Positive Result:** Reddish-brown or red ring at the interface

2. Libermann-Burchard Test

- **Reagent:** Acetic anhydride + concentrated sulfuric acid
- **Positive Result:** Green or blue coloration (used for detecting sterol-type terpenoids)

3. Thin Layer Chromatography (TLC)

- **Method:** Spot sample on TLC plate, develop in solvent system, visualize under UV or iodine vapors
- **Positive Result:** Distinct colored spots based on R_f values

4. Vanillin-Sulfuric Acid Spray

- **Reagent:** Vanillin + sulfuric acid (spray on TLC)
- **Positive Result:** Terpenoids show characteristic color changes (pink, purple, blue)

Glycosides & its Identification Tests

Definition

- Glycosides are compounds that consist of a sugar (glycone) and a non-sugar (aglycone or genin) part, linked by a glycosidic bond.

Occurrence:

- Common in higher plants; rare in lower plants.

Distribution:

- **Types:** Cardiac, cyanogenic, anthraquinone, saponin, and flavonoid glycosides.
- **Plant parts:** Found in leaves, seeds, barks, and fruits.
- **Examples:** Digoxin (*Digitalis* spp.), Amygdalin (*Prunus* spp.), Sennosides (*Senna* spp.).

Examples

- **Cardiac glycosides** (e.g., Digoxin from *Digitalis purpurea*)
- **Anthraquinone glycosides** (e.g., Senna from *Cassia angustifolia*)
- **Saponin glycosides** (e.g., Diosgenin from *Dioscorea* species)

Properties

- **Bitter or astringent taste.**
- Some glycosides are **water-soluble**.
- **Hydrolyzed by acids or enzymes** into sugar and aglycone.



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