

# **CHEMOTAXONOMY OR CHEMICAL TAXONOMY**

## **ROLE OF PHYTOCHEMICALS**

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## What is Chemotaxonomy?

- ❖ Chemotaxonomy = Chemo + Taxonomy.
- ❖ Phytochemical substances of taxonomic significance.
- ❖ The classification of plants on the basis of chemical contents is called chemotaxonomy or chemical taxonomy.
- ❖ These chemical constituents of plants differ from species to species and are restricted to certain taxa.

## Where Found ?

- ❖ Among most studied families from the chemotaxonomic point of view are:
  - Malvaceae,
  - Ranunculaceae,
  - Magnoliaceae,
  - Polygonaceae, and
  - Solanaceae.

## Types of phytochemical compounds

❖ They are of three types:

- 1. Primary constituents:** These include the macromolecular compounds e.g., proteins, nucleic acids, chlorophyll and polysaccharides.
- 2. Secondary constituents:** They include compounds not involved directly in plant metabolism e.g., **simple phenolic compounds** like caffeic, benzoic and nicotinic acids and **polyphenolic compounds** like flavonoids, terpenes, coumarines, alkaloids and **pigments**.
- 3. Miscellaneous substances.**

## What are these chemicals?

❖ The following chemicals are present in plants:

➤ Non - protein amino acids

➤ Phenolics

➤ Flavonoids

➤ Betalins

➤ Alkaloids

➤ Terpenoids and steroids

➤ Crystals

➤ Polysaccharides

➤ Oils, Fats and Waxes, etc.

## **Non – protein amino acids:**

- ❖ There are 300 non – protein amino acids in plants.
- ❖ For example,
  - Acetyl ornithine- identified as the main non-protein amino acid in Fumarioideae under the Fumariaceae.
  - Lathyrine – in Genus *Lathyrus*
  - Azetidine – 2 – carboxylic acid – in Families Liliaceae, Amaryllidaceae and Agavaceae, etc.

## **Phenolics:**

- ❖ Derivatives of phenolic compounds.
- ❖ For Example,
  - Leucoanthocynin – abundant in woody plants
  - Flavonols and methoxycinnamic acid – in herbaceous plants
  - Ellagic acid – in tribe Kerrieae of Rosaceae, etc.

## **Flavonoids:**

- ❖ Flavonoids are present in leaves, flowers and fruits.
- ❖ Flavonoids are further classified into various types:
  - ✓ Flavones — e.g. apigenin, levtolin
  - ✓ Flavanones — e.g. naringenin
  - ✓ Iso-flavones — e.g. orobol
  - ✓ Iso-flavonoids — e.g. ferreirin, etc .
- Hegnauer revealed that, the two families- Umbelliferae and Araliaceae by are closely related.
- Analysis of flavonoids of leaf of Liliaceae, Juncaceae, Cyperaceae and Poaceae by Williams suggest that all these families have arisen from Liliaceous ancestors.

## Betalins:

- ❖ Betalins are derivatives of phenols serving as pigments.
- ❖ They differ from flavonoids and other phenolic compounds in that they contain nitrogen in them.
- ❖ They are found in ten families of angiosperms
- ❖ For example,
  - The systematic position of the family Cactaceae under Centrospermae. It was placed in the order of its own i.e., the Cactales or Opuntiales. But, the presence of betalin in the Cactaceae establishes its position in the Centrospermae.
  - The genus *Gisekia*, based on morphological similarities was traditionally placed under Molluginaceae. But, since it contains betalains Takhtaja has recently transferred this genus to Phytolaccaceae.

## Alkaloids:

- ❖ Alkaloids are nitrogen containing compounds with a heterocyclic ring.
- ❖ There are about 5000 alkaloids in angiosperms
- ❖ For ex.
  - Isoquinoline – in Papaveraceae
  - Lupin – in Fabaceae
  - Tropane – in Solanaceae, etc.
- ❖ **Lupin** alkaloids have been found in three tribes under the subfamily Lotoideae of the Fabaceae suggesting that these tribes may have originated from a common ancestral stock.
- ❖ **Distribution of alkaloid** has proved useful in the taxonomy of the Fabaceae.
- ❖ The presence of **isoquinoline alkaloids** in the families Fumariaceae and Papaveraceae indicates very close relationship between the two families.
- ❖ Alkaloids are useful in taxonomic studies in *Papaver* and *Argemone* (Papaveraceae), *Veratrum* (Liliaceae), as well as in *Lycopodium*, *Lupinus* and *Caryophyllales* (Jones and Luchsinger).



## Terpenoids and steroids:

- ❖ **Terpenoids** are unsaturated hydrocarbons derived from isoprenes. Eg. Carotenoids, iridoids
- ❖ **Steroids** are saturated hydrocarbons with four rings in their structure. For ex., their distribution has proved helpful in the taxonomy of the genera of tribe Veratreae of family Liliaceae. According to Kupchan, these genera contain the steroid **veratum**.

## Crystals:

- ❖ Some plants have raphide crystals in different parts of their body.
- ❖ For Example,
  - Presence and absence of raphides are used in the grouping of plants in the family Rubiaceae.
  - Calcium oxalate crystals are present in the ovary walls of the members of Asteraceae, etc.

# Polysaccharides

- ❖ They offer the greatest hope for taxonomic evidence because of their complexity and diversity.
- ❖ For example,
  - MacLeod and McCorquodale studied the water-soluble polysaccharides in the seeds of 22 grass species. They found lesser or greater amounts of **0-glucosan** was present in all the Festuceae, but *Festuca* and *Lolium* are distinctive in having an unusual **trisaccharide**.
  - **Amyloid** was detected in 16 families of the Dicotyledons and none of the Monocotyledons by Kooiman in a test involving over 2,500 species.

## **Oils, Fats and Waxes:**

- ❖ Lipids are found in all parts of plants but are dominant in the storage organs, seeds and fruits.
- ❖ Waxes occur in the cuticular layers of plants.
- ❖ For example,
  - Ximenyric acid is found in the Olacaceae and Santalaceae.
  - Petroselinic acid is almost completely restricted to the Umbelliferae.
  - Erucic acid is restricted to Cruciferae.

## Immunological reactions:

- ❖ These type of reactions are studied in Serotaxonomy where the storage protein or pollen protein is injected from the plant body to a test animal usually mouse or rabbit called the test animal.
- ❖ The test animal produces antiserum against that protein which is mixed with the plant extract to detect the precipitate formed by antigen – antibody reaction.
- ❖ The nature and amount of precipitate indicate the relationship of the protein to the plant.
- ❖ High rate of precipitation indicates closeness of the plants.
  
- ❖ Closeness of *Delphinium* to *Aconitum* was confirmed by such serological studies.
- ❖ The genus *Hydrastis* placed in Berneridaceae is found to be more related to Ranunculaceae
- ❖ Serological method is also useful in the classification of the members of Fabaceae, Bromus, Potato, etc.



THANK YOU

