

Lecture: 31

SECONDARY METABOLITES - OCCURRENCE, CLASSIFICATION AND FUNCTIONS OF PHENOLICS

Secondary metabolites

- ❖ **Organic compounds** produced by the plants which have **no direct role in the growth and development** are called as **secondary metabolites**.
- ❖ There are about 100,000 secondary compounds that are produced by the plants and the structures of more than 15000 alkaloids, 30000 terpenes, several thousand phenyl propanoids, 1000 flavonoids, 500 quinones, 700 polyacetylenes and 800 non-protein amino acids have already been characterised.
- ❖ These secondary compounds produced by plants are grouped into **five** major groups.
 1. **Phenolics**
 2. **Terpenoids**
 3. **Alkaloids**
 4. **Special nitrogen metabolites**
 5. **Cuticular compounds**

Phenolics

- ❖ Phenolics are a group of compounds characterized by at least **one aromatic ring bearing one or more hydroxyl groups**.
- ❖ Most of the thousands of phenolics known to date are of plant origin.
- ❖ These phenolic compounds are biosynthesised through **shikimate pathway**.

Shikimate pathway

- ❖ Shikimate pathway is an important pathway in plants through which many secondary plant products are synthesised.
- ❖ The **key starting materials** are **phosphoenolpyruvate (PEP)** and **erythrose 4P** derived from glycolysis and pentose phosphate pathways, respectively.
- ❖ These two compounds condense to produce a six carbon cyclic compound with one carbon (COOH) side chain namely **shikimate**.
- ❖ Then shikimate is phosphorylated and condensed with another molecule of PEP to produce a cyclic compound containing a three carbon and one carbon side chains.
- ❖ This is finally converted to aromatic amino acids **phenylalanine and tyrosine**.
- ❖ These amino acids are **deaminated** followed by **hydroxylation** at different carbon atoms in the aromatic ring to form **cinnamic acid derivatives**.

- ❖ These cinnamic acid derivatives are utilised for the synthesis of different phenolic compounds.

Functions of phenolics

- Phenolics are of great importance as **cell wall components**.
- They form **part of cell wall structures** such as **lignins, cutins and suberins**, which provide **mechanical support and function as barriers against microbial attack**.
- The **flavonoids and anthocyanins** contribute to flower and fruit colours. This is important for attracting insects and animals to the plant for pollination and seed dispersal.
- Phenolics also play a **defensive role** in plants by protecting against predators.
- Simple phenolic acids, polyphenolics like tannins and phenolic resins at the plant surface are **effective feeding deterrents**.
- Phenolics are accumulated as **post-infectious low molecular compounds** called **phytoalexins** as a result of microbial attack.
- Among the phenolic phytoalexins, hydroxycoumarins and hydroxycinnamate conjugates contribute to **disease resistance mechanism** in plants.
- Phenolic compounds also produce **allelopathic effect**. A well known compound from Juglans species is juglone which is highly toxic for a wide range of plants. It occurs in the plant as a non-toxic glucoside and is made active by deglucosylation and oxidation after leaching from the leaves into the soil.
- Phenolics also function as **signal molecules** in the interaction between **nitrogen fixing bacteria and leguminous plants**.
- These plants exude **flavonoids** which act selectively in Rhizobia as **inducers of nodulation gene transcription**.
- Salicylic acid is strongly implicated as a **signal molecule** which induces active defense responses in several plant species against many types of pathogens.
- Recently, it has been shown that phenolic compounds function as **effective antioxidants**.
- Polyphenolics are important in **foodstuffs, wines and herbal teas** because of their **astringent taste**.
- Plants rich in polyphenolics were used as **tanning agents** in leather industries.
- **Phenolic pigments** (anthocyanins, flavones etc) of fruits are most widespread food colours occurring in fruit juices, wines and jams.
- Anthocyanins have considerable potential in the food industry as **safe and effective food additives**.