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FACULTY OF ENGINEERING & TECHNOLOGY

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LECTURE 9

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PRODUCTION OF SECONDARY METABOLITES & INDUSTRIAL PRODUCTS

What are secondary metabolites?

- Secondary metabolites are generally defined as small organic molecules produced by an organism that are not essential for their growth, development and reproduction.

- They may include pharmaceuticals, flavours, fragrance, food additives, feedstock etc.

- Secondary plant metabolites like alkaloids, terpenoids, flavonoids, lipids, oils, tannins, anthraquinones, flavones, napthaquinones, vitamins, proteins, anticancer agents, antiviral agents etc. are isolated from plant tissue culutre.

Why plant produce secondary metabolites?

- Plant hormones, which are secondary metabolites, are often used to regulate the metabolic activity within cells and oversee the overall development of the plant
- It protect plant against herbivores and microbial pathogens.
- It serves as attractants for pollination and seed dispersing animals.

Production of phytopharmaceuticals and secondary metabolites.

a) Biotransformation (Biochemical Conversion)
b) Plant cell immobilization
c) Genetic transformation (Transgenic plant)
d) Elicitors

List of few secondary metabolites derived from plant tissue culture

Compound	Plant species	Culture type
Anthraquinones	*Cassia angustifolia*	Callus
Caffeine	*Coffee arabica*	Callus
Cardenolides	*Digitalis purpurea*	Suspension & Callus
Codeine	*Papaver somniferum*	Suspension
Diosgenin	*Dioscorea composita*	Callus
Glycyrrhizin	*Glycyrrhiza glabra*	Suspension
Papain	*Carica papaya*	Callus
Reserpine	*Rauwolfia serpentina*	Suspension
Rosmarinic acid	*Coleus blumei*	Callus & Suspension
Trigonelline	*Trigonella foenum-graecum*	Suspension
Vinblastine	*Catharanthus roseus*	Callus
Visnagin	*Ammi visnaga*	Suspension
Xanthotoxin	*Ruta graveolens*	Suspension

A. Biotransformation (Biochemical Conversion)

It is a process through which the functional group of organic compounds are modified by living cells.

This process can be done by using microorganism or plant cell suspension, hairy root culture and immobilized cell.

Biotransformation by plant cell cultures yield a wide range of reactions, such as glycosylation, glucosyleserification, hydroxylation, oxido-reductions, hydrolysis, epoxidation, isomerisation, methylation, demethylation and dehydrogenation etc.

It not only increases the yield but also very economical for commercial production.

B. Plant cell Immobilization: Discussed earlier.

C. Genetic transformation (Transgenic plant)

- The plants obtained through genetic engineering contain a gene usually from an unrelated organism, such genes are called transgenes, and the plants containing transgenes are called as transgenic plants.
- Genetic transformation can be defined as the transfer of foreign genes (DNA) or the recombinant DNA isolated from plants, viruses bacteria into a new genetic background.
- The targeted cells for gene transformation are cultured cells or protoplast, meristem cells from embryos, pollens, zygote and cells from immature embryos, shoots and flowers.

Application

- ✓ Genes have been successfully transferred to many crops for resistance to various biotic stresses.
- ✓ Genes resistant to abiotic stresses like herbicide resistance.
- ✓ Resistance against viral infection.
- ✓ Gene transfers to improve quality of food products.
- ✓ Male sterility and fertility restoration in transgenic plants.
- ✓ Transgenic plants have both basic and applied role in crop improvement. E.g. Tobacco, tomato, soybean, Satavari, papaya, liquorice, neem etc.

D. Elicitors

- Elicitors are organic/inorganic agents used in tissue culture to trigger rapid and increase production of secondary metabolites or rapid growth of plant cell culture/organs.
- Induction of stress in plant cultures in terms of specific environmental, physiological & biological conditions, to enhance the production of secondary metabolites, is known as Elicitation.
- The secondary compounds synthesized & accumulated in response to such conditions are called '**Phytoalexins'**, which act as defense agent to invading pathogens. The signals triggering the formation of phytoalexins are called **elicitors**.

Classification of Elicitors

i. Based on Origin

1. Exogenous elicitors: Enzymes, metal ions, U.V. Light, chitosan etc.
2. Endogenous elicitors: Hepta-β-glucoside, Dodeca β-1,4 D-galacturonide etc.

ii. Based on nature

1. Biotic elicitors
2. Abiotic elicitors

1. Biotic elicitors

- ✓ They are derived from microorganisms or produced within the plant cells by plant defensive process against microbial infection.
- ✓ They include mainly β-Linked glucans, chitosan, enzymes, cell wall derived polysaccharides like pectin, pectic acid, cellulose, etc.
- ✓ These elicitors when added to medium in low concentration (50- 250ng/l) enhance metabolite production.

2. Abiotic elicitors

- ✓ Product accumulation also occurs under stress caused by physical or chemical agents like UV, low or high temperature, antibiotics, salts of heavy metals, freezing and thawing cycles, non-essential components of media (agarose, tin, and agaropectin), certain chemicals (methyl jasmonate, copper sulphate, silver nigtrate etc.), and high salt concentration grouped under abiotic elicitors.

Elicitors stimulated the accumulation of secondary metabolites in different plant culture like Opium, Dioscorea, Datura, Vinca, Capsicum, Carrot etc.

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