CYTOKININS: NATURE, TRANSPORT, MODE OF ACTION & PHYSIOLOGICAL EFFECTS

MBOTCC-7
UNIT-III

M. Sc. Sem-II
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Discovery & Characterization:

(i) Cytokinins were discovered through extensive and ingenious experiments of Skoog on tobacco for over a decade (1945-1955).

- When stem segments of tobacco consisting of cortical, vascular and pith tissues were cultured on a medium containing Auxin, pith cells were found to proliferate.

- If, however, pith tissue alone was cultured on the same medium, cells enlarged but did not divide. Cell division in this medium was induced if pith tissue was placed in contact with vascular tissue or if an extract of vascular tissue was added.

- Clearly the vascular tissue contained a substance which promoted cell division in tobacco pith.

(ii) Cell division promoting substance was also found in coconut milk (liquid endosperm).

(iii) The above active substance was later termed Kinetin (1956) and was identified as 6-(furfurylamino) purine.

(iv) Kinetin does not occur in plant tissues, but substances with similar biological activity were shown to be widely distributed in plants.

(v) The term 'Kinetin' was later replaced by another popularly accepted term 'Cytokinin'.

(vi) Thus Cytokinin is regarded as a substance which promotes cell division.

(vii) First isolation and identification of a naturally occurring Cytokinin could be made in 1963.

(viii) Letham (1963) identified a Cytokinin, now

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known as Zeatin, from immature maize seeds.
-Several other Cytokinins were isolated in 1973.

(ix) Distribution of Cytokinins in tRNA Species from different sources forms an interesting story. Zachau et al. (1966) first identified it as a constituent of two $tRNA^{Ser}$ species from yeast.

(x) Cytokinins have also been detected in several marine algae and certain freshwater algae.

Transport of Cytokinins:

(i) The picture of cytokinin translocation is not very clear.

(ii) There is evidence to suggest that the cytokinin synthesized in the root tips is transported to the leaves and to the rest of the plant body via the xylem sap.

(iii) However, cytokinin synthesized in other parts of the plant does not appear to be translocated.

(iv) Some evidences suggest that it is the conjugated types of cytokinins (eg., Ribosides) that are transported rather than the free purine types (eg. Z).

Mode of Action of Cytokinins:

(i) Presence of two metabolically distinct types of cytokinin (free Cytokinins and tRNA-cytokinins) has complicated the situation.

(ii) Biochemical mode of action of the tRNA-cytokinins appears to be concerned with protein biosynthesis at the translational level.

(iii) Biochemical mode of action of free cytokinins in plants is unknown.

(iv) It is presumed that the cytokinin-receptor complex switches on or off some metabolically important step which results in observed physiological effects.

(v) Fox and Erin (1975-77) observed that cytokinins bind with quite high specificity to ribosomes in higher plants.

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They isolated three cytokinin-binding proteins from wheat ribosomal proteins which they called CBF-1, CBF-2 and CBF-3. CBF-1 and CBF-2 had high affinities for cytokinins whereas CBF-3 had a low affinity.

(vi) The mode of action of cytokinins in delaying leaf senescence has received some attention. RNA content of leaves declines during senescence.

Decline in protein and RNA content in senescing leaves is primarily due to increased breakdown of proteases and RNA-ase.

(vii) Cytokinins have been shown to slow down the rate of protein and RNA loss in detached leaves. This occurs probably by suppressing the synthesis of proteases and preventing any increase in RNA-ase activity.

Physiological Effects:

Two broad categories of physiological influences of cytokinins have been observed:

(a) Promotion of cell division and differentiation and,

(b) Retardation of senescence

Effects on cell division and differentiation:

(i) This was first observed in plant tissue cultures.

(ii) It is now well established that cytokinins act as a specific trigger for mitosis. Probably they can do so both ~~the~~ in cultured cells as well as in whole plants.

(iii) Cytokinins also play an important role in cell differentiation and organogenesis in plant tissue cultures.

(iv) They also promote germination of some seeds.

(v) They also induce tuberization (tuber formation in potato stolons.

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(vi) Cytokinins also promote bud development.

(vii) They appear to play a role in overcoming apical dominance.

Effects on retardation of Senescence:

(i) Retardation of senescence under the influence of cytokinins is best observed in leaves.

(ii) Such influence was first observed by Chibnall (1930s), and later by Richmond (1957).

(iii) Cytokinins produced in the roots are translocated via the xylem sap to the leaves where they promote key metabolic processes and thus maintain the structural and functional viability of the leaves.

Thus it follows that senescence occurs when the supply of cytokinin to the leaves or the active cytokinin content of the leaves falls.

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