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Perspective

Role of Phenols in the Development and Growth of Plants

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DESCRIPTION

Phenolics play important roles in plant development, particularly in lignin and pigment biosynthesis. They also provide structural integrity and scaffolding support to plants. Plant phenolic compounds can act as antioxidants, structural polymers lignin, attractants flavonoids and carotenoids, UV screens flavonoids, and signal compounds salicylic acid and flavonoids and defense response chemicals tannins and phytoalexins. Cocoa, potato, yam, tomato, kale, Brussels sprouts, broccoli and others dark green leafy and brightly-colored vegetables as well as legumes and cereals, in addition to spices and fruits such as cherries and citrus, are particularly rich in phenolic compounds. Some phenolic compounds, such as lignin, provide structural support to plant tissues. Phenol extraction of proteins is an alternative method to classical TCA-acetone extraction. It allows efficient protein recovery and removes nonprotein components in the case of plant tissues rich in polysaccharides, lipids, and phenolic compounds.

Tannins are a group of polyphenolic compounds commonly found in fruits, seeds, bark, and leaves. They are subdivided into hydrolyzable tannins and condensed tannins. Hydrolyzable tannins, such as gallotannins and ellagitannins, are formed by esterification of gallic acid or ellagic acid with multiple sugar molecules. Condensed tannins, also known as proanthocyanidins, are polymers of flavan-3-ols. Lignin is a complex phenolic polymer that strengthens cell walls, allowing plants to grow upright and providing mechanical support. Phenolic compounds serve as natural defense agents against pathogens, including bacteria, fungi, and viruses. They can inhibit the growth and proliferation of pathogens by acting as antimicrobial agents. Phenols also help in the formation of physical barriers and callus tissues at the site of infection, limiting the spread of pathogens.

Plants are exposed to harmful ultraviolet (UV) radiation from sunlight. Phenolic compounds, such as flavonoids, act as natural sunscreens by absorbing UV light and protecting the plant's genetic material and photosynthetic machinery from damage. Phenolic compounds possess strong antioxidant properties, which help plants combat oxidative stress. They scavenge Reactive Oxygen Species (ROS), which are generated during various cellular processes, and prevent oxidative damage to cell membranes, proteins, and DNA. Phenolic compounds can influence the growth and development of neighboring plants by exerting allelopathic effects. Certain phenols released by one plant can inhibit the growth of nearby plants, reducing competition for resources like water, nutrients, and light. Some phenolic compounds, particularly flavonoids, are involved in floral pigmentation and aroma production. These compounds attract pollinators, such as bees and butterflies, by providing visual and olfactory cues, thereby enhancing pollination and ensuring reproductive success. Phenolic compounds are synthesized in response to various environmental stresses, including drought, salinity, extreme temperatures, and heavy metal toxicity. They help plants cope with these stresses by regulating physiological processes, scavenging free radicals, and stabilizing cell membranes. Certain phenolic compounds, such as auxins, play a role in regulating plant growth and development. Auxins control cell elongation, root formation, and apical dominance, influencing various aspects of plant architecture. The chemical composition and abundance of plant phenols can vary greatly depending on the plant species, part of the plant, growing conditions, and maturity stage. Different plants may contain a combination of these subclasses, and the specific phenolic compounds present can differ significantly.

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