

Chapter 2

Biochemistry and Molecular Mechanisms of Flavonoids

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Abstract

Flavonoids are a diverse group of polyphenolic compounds widely distributed in plant-based foods and play a significant role in human nutrition and health. As secondary metabolites, polyphenols—including flavonoids—contribute to plant pigmentation, reproduction, and defense mechanisms. Structurally, flavonoids possess a characteristic 15-carbon skeleton comprising two benzene rings (A and B) linked by a heterocyclic pyran ring (C ring). They occur naturally in both aglycone and glycosylated forms, with more than 8000 flavonoid molecules identified to date. Common dietary sources include fruits such as apples, grapes, citrus species, and berries, as well as vegetables like onions; beverages including tea and red wine; and plant-derived products such as olive oil.

Extensive epidemiological and experimental evidence highlights the therapeutic potential of flavonoids in preventing and managing multiple diseases. Their biological activities encompass antioxidant, anti-inflammatory, analgesic, anti-proliferative, anti-cancer, anti-angiogenic, anti-microbial, anti-viral, and neuroprotective effects. These functions are largely attributed to their ability to modulate oxidative stress, regulate signaling pathways, and influence gene expression involved in inflammation, cell proliferation, and apoptosis. Flavonoids also play an important role in metabolic health by improving insulin sensitivity and reducing the risk of metabolic disorders.