



PLANT CHEMISTRY

Plant Secondary Metabolites in Ecological, Biochemical, and Agricultural Systems

Edited by Azamal Husen



CRC Press
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Plant Secondary Metabolites in Ecological, Biochemical, and Agricultural Systems

Plants survive in complex and competitive environments by producing an extraordinary array of secondary metabolites that protect, signal, and strengthen them under stress. *Plant Secondary Metabolites in Ecological, Biochemical, and Agricultural Systems* offers a comprehensive exploration of these powerful natural compounds and their multifaceted roles in plant defense, ecological interactions, and sustainable crop production. Bringing together cutting-edge scientific insights from plant biochemistry, ecology, and agriculture, this volume examines major classes of secondary metabolites, their biosynthesis, stress responses, ecological roles, and applications in modern farming. With the increasing demand for environmentally safe alternatives to synthetic agrochemicals, this book highlights how natural plant compounds can support pest management, improve crop resilience, enhance soil health, and reduce environmental impact. An essential reference for researchers, advanced students, agricultural professionals, and biotechnologists, this book provides timely knowledge and practical perspectives for developing future sustainable farming strategies grounded in nature's own defense mechanisms.

Salient features:

- Provides an in-depth understanding of how plant secondary metabolites support natural defense, stress tolerance, and ecological interactions.
- Highlights eco-friendly, biologically grounded alternatives to synthetic pesticides, fertilizers, and growth regulators for sustainable agriculture.
- Integrates biochemistry, ecology, molecular biology, and agricultural science to present a holistic perspective on plant defense systems.
- Includes cutting-edge scientific advances in metabolic engineering, genomics, and biotechnology for enhancing crop protection and productivity.
- Serves as a valuable reference for researchers, postgraduate students, biotechnologists, and agricultural professionals working toward sustainable farming solutions.



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Nilofer, Abdul Mazeed, and Mohammad Israil Ansari

6.1 INTRODUCTION

Flavonoids are a diverse and ubiquitous group of polyphenolic secondary metabolites found across the plant kingdom, characterized by their C6–C3–C6 carbon backbone. As key components of plant secondary metabolism, these compounds are not directly involved in growth or reproduction but are essential for plant survival and adaptation to environmental challenges. Flavonoids contribute to a range of physiological processes, including pigmentation, protection against ultraviolet (UV) radiation, and defense against pathogens and herbivores. Their discovery traces back to the 19th century, with early investigations into plant pigments, such as the isolation of anthocyanins responsible for flower and fruit coloration. Pioneering work by chemists like Heinrich Wieland and Robert Robinson in the early 20th century laid the foundation for flavonoid classification, which has since expanded with modern analytical

techniques like high-performance liquid chromatography (HPLC) and nuclear magnetic resonance (NMR) (Bohm, 1998). These advancements have revealed a vast array of flavonoid subclasses, including flavones, flavanols, flavanones, isoflavones, anthocyanidins, flavan-3-ols, and chalcones, each distinguished by unique structural modifications such as glycosylation, methylation, or acylation.

The study of flavonoids is highly relevant across multiple disciplines due to their multifaceted roles (Figure 6.1). In plant biology, flavonoids are critical for mediating interactions with the environment, such as attracting pollinators through vibrant flower pigmentation or shielding plants from UV-induced damage via their light-absorbing properties. In agriculture, understanding flavonoids enables the development of crops with enhanced resistance to pests, diseases, and environmental stresses, as well as improved traits for pollinator attraction, which can boost yield and sustainability (Shah and Smith, 2020). Ecologically, flavonoids play

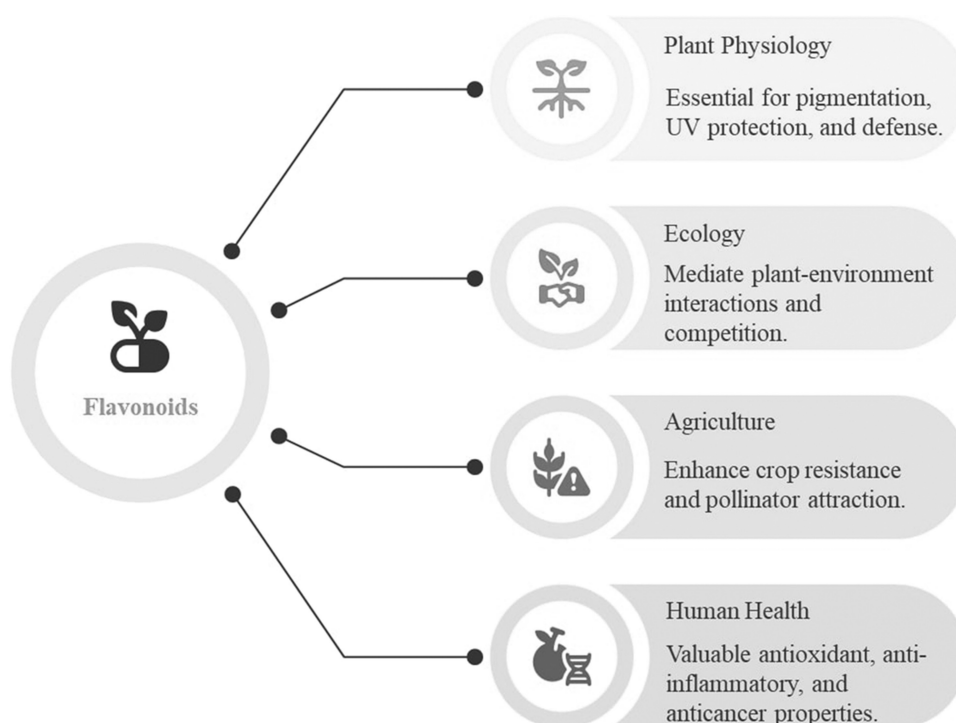


FIGURE 6.1 Unveiling the multifaceted roles of flavonoids.