Chapter 1
Techniques and Tools in Secondary Metabolite Analysis

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ABSTRACT

Secondary metabolites are diverse, biologically active compounds that play critical roles in ecological interactions, such as defence mechanisms, signalling, and competition etc of the organism. These compounds are difficult to detect due to their low abundance and complexity but hold significant potential in unravelling biological processes. The complexity and diversity of secondary metabolites depends on innovative methods to improve detection. The study of secondary metabolites involves a wide range of analytical techniques aimed at identifying, characterizing, and quantifying these compounds. This chapter provides a comprehensive overview of various analytical methods used to study secondary metabolites, highlighting their importance in unravelling the complexity of these compounds and their bioactive potential.

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1. INTRODUCTION

1.1. Definition and Significance

Plants synthesize various types of substances which can be categorized into both primary and secondary metabolites, that are essential for the growth, development and defence of plant species (Reshi et al 2023). The metabolites directly involved in plant growth and developmental processes, and contribute towards essential cellular pathways like respiration, cell division, and photosynthesis, are categorized as the Primary metabolites. (Tariq et al 2023). On the contrary, few metabolites play diverse roles, including plant survival mechanisms against various biotic and abiotic stresses, and have been categorized as the Secondary metabolites (Chen et al 2022). Their production is primarily under the inducible control of defensive transcriptional factors, subjected to recognition of various stimuli, both internal as well as external, through plant receptors (Chen et al 2022). In addition, the secondary metabolite production is also triggered in plants during different developmental stages, physiological conditions and environmental interactions, such as mutualism, pathogenicity and herbivory (Chomel et al 2016).

1.2. Classification of Secondary Metabolites

Plant secondary metabolites have been categorized into various groups based on functional groups and chemical structure (Teoh 2016). These groups include:

1. Terpenes (including volatile compounds, sterols, and carotenoids),
2. Polysaccharides and Hydrocarbons
3. Phenolic compounds,
4. Phytoalexins (sulfur-containing compounds),
5. Alkaloids (nitrogen-containing compounds),
6. Flavonoids

However, polysaccharides mostly comprise of carbon and hydrogen as base elements, or their derivatives, hence we have included them under the single head group in the sub-sequent sections. Also, plant hormones, such as abscisic acid, gibberellic acid, jasmonic acid, polyamines, and salicylic acid, are derivatives of these above secondary metabolites.

We will discuss each of these in the following sub-sections: