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Chapter

Introductory Chapter: An Overview on Bioactive Compounds with Focus in the Biosynthesis, Characterization and Applications

Tatiele Casagrande do Nascimento, Eduardo Jacob-Lopes and Leila Queiroz Zepka

1. Overview

Natural compounds have been used globally for thousands of years [1]. However, currently, a world trend towards health has considerably boosted the search for natural alternatives for health promotion [2]. Several naturally synthesized compounds have bioactive functions and have been explored for different applications, especially in the food and pharmaceutical industry. These substances are chemical structures that perform specialized functions at the biological level [3].

According to a consensus established by [4], bioactive compounds are naturally occurring essential and non-essential compounds that can positively influence human health. Nutritionally, they have also been called nutraceuticals since 1979 because when ingested, they provide health benefits beyond basic nutrition [4].

Bioactive compounds make up a highly heterogeneous set of molecules with different chemical structures and distributions in nature [5]. Broadly, these metabolites are divided into three main groups: terpenes and terpenoids, phenolic compounds and alkaloids [3]. Among them, carotenoids, sterols, flavonoids are frequent examples.

Most of the bioactive terpenes investigated are tetraterpenes with C40 skeletons [6]. formed from eight isoprenoid units (C5) and characterized by a central sequence of conjugated double bonds [7]. Similarly, sterols also belong to the group of terpenes, and they are triterpenes (C30) with a basic structure consisting of a tetracyclic ring and a C17 side chain [8]. The phenolic compounds flavonoids have low molecular weight, are consisting of 15 carbon atoms, organized in the basic configuration C6-C3-C6 [9]. In contrast, alkaloids are usually heterocyclic organic compounds (basic pH) that contain nitrogen atoms [10].

In addition to the main groups, other molecules have been shown some bioactivity, such as polysaccharides, amino acids and peptides, indicating that the diversity of bioactive compounds is comprehensive and is in a growing process of exploration and investigation in various sources.

Microorganisms, plants and animals offer many bioactive products of great interest for application in the food and pharmaceutical industry [3, 11]. According to [12], more than 80% and 30% of the active compounds used in food and medicine, respectively, are obtained from natural sources.

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Terpenoids generally constitute the largest and most diverse class of secondary metabolites in natural products. For example, it is estimated that more than 1200 natural carotenoids have been characterized from different sources, including plants, fruits, vegetables and microorganisms [6]. Sterols are present in most living organisms, including vertebrates, invertebrates, plants, fungi, and bacteria [13]. According to [14], sterols that occur plant, animal, and microbial are called phytosterols, zoosterols, and mycosterols.

On the other hand, phenolic compounds (including flavonoids) are widely distributed in the plant kingdom, are present in fruits, leaves, seeds and glycosylated in other parts of the plant [15]. Most known alkaloids are isolated from plants. However, they have also been reported in microorganisms, marine organisms, and terrestrial animals [10].

Regardless of the source, bioactive compounds must be obtained (isolated or extract) from some extraction technique. They are conventionally solvent extracted, considering important aspects such as solvent-compound affinity, extraction time and temperature. However, emerging technologies such as ultrasound, pulsed electric field, enzymatic digestion, extrusion, microwave, ohmic heating, supercritical fluids are increasingly used due to greater sustainability and efficiency [3, 12].

In terms of biosynthesis, bioactive compounds can be formed in different ways. Terpenes are biosynthesized via the cytosolic mevalonic acid (MVA) pathway and the methylerythritol phosphate (MEP) pathway [16]. The biosynthesis of phenolic compounds involves several pathways, the shikimic acid pathway, phenylpropanoid and flavonoid pathways [9]. In contrast, the shikimic acid pathway is the main route involved in alkaloid biosynthesis [17].

The benefits of these compounds are a consequence of several proven bioactive properties, mainly antioxidant, anti-inflammatory and antimicrobial effects [8].

In general, most bioactive compounds have a marked antioxidant capacity due to their ability to capture reactive species [8]. Furthermore, they improve endogenous antioxidant defenses in vivo, allowing an attractive therapeutic approach against oxidative stress and related diseases [18].

The role of bioactive in inflammatory processes is evidenced by reducing signalers such as pro-inflammatory cytokines, chemokines, interleukins, inducible enzymes (cyclooxygenase-2 and inducible nitric oxide synthase) and inflammatory mediators (prostaglandins, leukotrienes and thromboxane). These pathological events are associated with the development and progression of most chronic diseases, such as type II diabetes mellitus, obesity, neurodegenerative disorders, cardiovascular diseases and cancer [19].

The antimicrobial activity of bioactive compounds has been reported for different microorganisms [20]. This activity is often associated with phenolic compounds, and it is believed that they use active redox metals from the microbial cell, causing an imbalance in the redox state and consequently cell death [21].

In addition to these mentioned properties, several other effects are associated with bioactive compounds, including anticancer, neuroprotection, hepatoprotective, immunomodulatory activities and dyslipidemias control [18, 22–25].

The chapters presented in this book provide a reliable compilation of biosynthesized active compounds with proven activities that can contribute to the development of products by industry.

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