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Editorial

Special Issue: Isolation and Utilization of Essential Oils: As Antimicrobials and Boosters of Antimicrobial Drug Activity

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In the search for new antimicrobial lead compounds, interest in natural-product-based screening has enjoyed a renaissance, driven by the fact that plants present a unique pool of compounds. Volatiles produced by plants and present in essential oils possess a broad spectrum of biological properties with applications in many revenue-generating sectors, such as the pharmaceutical, nutraceutical, cosmetic, perfume, agronomy, and sanitary industries. Essential oils are a complex blend of small volatile molecules playing an important role in plant-defensive response to various insults, including microbial attacks, and their broad-spectrum antimicrobial activities have generated impressive scientific reports. Furthermore, due to their multicomponent nature, essential oils have low potential for the development of microbial resistance. The combination of antimicrobial agents with natural products have recently become a research priority. Synergistic interactions between essential oil constituents and antimicrobials are very promising approaches to overcome microbial resistance. The combinations of essential oil constituents and antimicrobial drugs can exert a multitarget activity, being effective in reducing or reversing microbial resistance. Additionally, such combinations have the advantage of reduced effective doses of both antimicrobial and essential oils, being consequently less toxic than separated components. The encapsulation of essential oils in nano- and micro-delivery systems (molecular inclusion complexes, polymeric and colloidal systems) is another promising antimicrobial strategy that is currently extensively investigated. The formulation of essential oils is an efficient approach to boost their antimicrobial activity against different pathogens; it allows overcoming some limitations that result from their physicochemical properties, such as low water solubility, high volatility, and chemical instability.

The main focus of this thematic collection was placed on the antimicrobial activity of essential oils and their combinations, including the eradication of the existing biofilms; the explanation of mechanisms underlying antimicrobial activity; and the preparation of stable formulations with essential oils boosting their antimicrobial activity and providing greater stability. These issues were addressed in four research papers and three reviews, which present novel advances in the development and application of essential oils as antimicrobial agents via combinatorial and nano-based approaches.

Azevedo et al. [1] developed a stable nanoemulsion (NE) containing *Croton cajucara* 7-hydroxycalamenene-rich essential oil (NECC) with antifungal activity. The authors found the best NECC antifungal activities against *Mucor ramosissimus* (MIC = 12.2 µg/mL) and *Candida albicans* (MIC = 25.6 µg/mL). The formulation totally inhibited extracellular proteases secreted by both studied species and showed no hemolytic effect at the highest tested concentration (2 mg/mL).

Widelski et al. [2] analyzed a panel of essential oils obtained from selected Apiaceae species cultivated in Poland. Eos obtained from *Heracleum dulce*, *Seseli devenyense*, and

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Seseli libanotis exerted the strongest antimicrobial activity, mostly against Gram-positive bacterial strains.

Pachi et al. [3] tested the antimicrobial activities of Chios Mastic Gums (CMGs) with their respective Chios Mastic Oils against fungi and bacteria. They found a moderate antimicrobial activity of mastic and its essential oil and proposed an HPTLC method for the standardization and assessment of the ageing effect on the oil's composition.

Peruč et al. [4] investigated the biofilm degradation ability of *Juniperus communis* and *Helichrysum italicum* EOs against nontuberculous mycobacteria found in plumbing systems, including pipes, tanks, and fittings. They found that *H. italicum* EO showed the strongest biofilm degradation ability against tested strains. Additionally, synergistic combinations of both EOs were effective against investigated mycobacterial strains and can be regarded as potential biofilm degradation agents for use in small water systems such as baths or hot tubs.

Sebaaly et al. [5] discussed the chitosomal encapsulation of EOs in order to ensure targeted delivery and boosted antimicrobial efficacy. Chitosomes, chitosan-coated liposomes, were shown to be a promising strategy overcoming major drawbacks related to the chemical properties of EOs (low water solubility, sensitivity to oxygen, light, heat, and humidity) and their poor bioavailability. The high biocompatibility and biodegradability of chitosan forming polymeric layers on conventional liposomes opens new potential applications as drug delivery systems in the pharmaceutic, cosmetic, and food industries.

Nuță et al. [6] targeted the rising problem related to the occurrence of biofilm-associated ailments. They presented the current literature data on the applications of EOs in chronic wounds and biofilm-mediated infections treatment, alongside the mechanisms of the microbicidal and antibiofilm activity of EOs. The synergistic activity of EO and other antimicrobials, as well as the use of EOs in food industry and as air disinfectants, were also discussed. The same authors raised an issue of difficulties in testing antimicrobial activity of EOs due to their lipophilicity and volatility, and several methods to overcome such challenges were proposed.

Leong et al. [7] provided an insight into the different aspects of antimicrobial activity exhibited by lavender essential oil and its constituents, which are known for their wound healing effects. The authors discussed the synergistic effects displayed by combinatory therapy involving this EO and explored the significance of nano-encapsulation in boosting its antimicrobial effects.

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