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Editorial

Essential Oils as Natural Food Preservatives: Opportunities and Challenges

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The use of medicinal plants is deeply rooted in human history, dating back to ancient civilizations. Recent years have seen an increase in studies reporting the beneficial properties of medicinal plants and spices, including their anticancer, antibacterial, antiviral, and antifungal activities. Essential Oils (EOs) are aromatic and volatile extracts obtained from various plant parts such as seeds, flowers, peels, stems, and bark. EOs are complex mixtures of secondary metabolites crucial for plant defense and survival. EOs exhibit significant antibacterial, antifungal, antiviral, antiparasitic, and anticancer activities, along with antioxidant properties, which made them a potential natural candidate for various applications in food, medicine, pharma, etc. (Boruah *et al.*, 2023; Mozaffari Nejad, Bayat and Ahmadi, 2013; Mozaffari Nejad *et al.*, 2018).

Growing concerns regarding the use of synthetic food preservatives—such as sodium benzoate, potassium bromate, sorbates, propyl paraben, formaldehyde, sodium nitrite/nitrate, butylated hydroxytoluene (BHT), and butylated hydroxyanisole (BHA)—are primarily associated with their potential adverse effects on human health, including possible genotoxicity, disruption of the gut microbiome, and pro-inflammatory responses. Consequently, there has been a notable shift toward the use of natural additives and preservatives. In this context, given their broad spectrum of bioactivities, essential oils (EOs) have attracted increasing attention as natural alternatives for reducing reliance on synthetic preservatives while enhancing food preservation and stabilization (Diogo Gonçalves, Paiva-Cardoso and Caramelo, 2025; Mafe and Büsselberg, 2025; Shanmugavel *et al.*, 2020; Shi *et al.*, 2024).

Some EOs, such as lemon, orange, peppermint, rosemary, cinnamon, and vanilla oil, are commonly explored in the food industry for their aromatic properties and potential preservative effects, contributing to the flavor and aroma of products like candies, gum, beverages, and desserts (Jaramillo Jimenez, Awwad and Desgagné-Penix, 2024; Silva *et al.*, 2013; Xu *et al.*, 2024). EOs from cloves, rosemary, and thyme can extend the shelf life of foods, while compounds such as carvacrol (from oregano and thyme) and cinnamaldehyde (from cinnamon) exhibit broad-spectrum antimicrobial activity, enhancing the safety of fresh produce, meat, and dairy products (Siroli *et al.*, 2015; Nieto, 2020; Harmankaya *et al.*, 2024; Ismael and Hadi, 2024; Jaramillo Jimenez, Awwad and Desgagné-Penix, 2024). In addition to their preservative effects, EOs may play a significant role in reducing food waste. By delaying microbial spoilage and oxidative degradation, EOs extend the shelf life of perishable foods, thereby minimizing losses throughout the food supply chain. Their incorporation into food systems can therefore contribute to both product stability and waste reduction (de Chiara *et al.*, 2026; Diogo Gonçalves, Paiva-Cardoso and Caramelo, 2025; Salanță and Cropotova, 2022). By replacing artificial additives, EOs allow manufacturers to meet the growing demand for natural, clean-label food options (Choi *et al.*, 2024; Diogo Gonçalves, Paiva-Cardoso and Caramelo, 2025).

Despite these potential applications, a major challenge for the widespread adoption of essential oils is their intense

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flavor and aroma, which can negatively impact the sensory profile of food products. To address this, researchers are developing microencapsulation techniques and synergistic blends aimed at improving EO stability and efficacy while minimizing sensory alterations (Hassid *et al.*, 2025; Reis, Ambrosi and Luccio, 2022; Szpicer *et al.*, 2025). The successful integration of EOs into the food industry relies heavily on the GRAS (Generally Recognized as Safe) status provided by regulatory bodies. This status, granted to many essential oils like rosemary and oregano, allows for their use as natural preservatives without formal pre-market approval (Hassid *et al.*, 2025; Rani, Kumar and Chauhan, 2025). Advancing the use of EOs in the food industry requires close collaboration between universities and industry. Academic research is essential for identifying bioactive compounds and evaluating their antimicrobial activity, while the food industry plays a critical role in translating these findings into scalable applications that meet consumer expectations. Such partnerships are vital to developing effective, plant-based preservatives that align with the growing demand for clean-label and natural food products.

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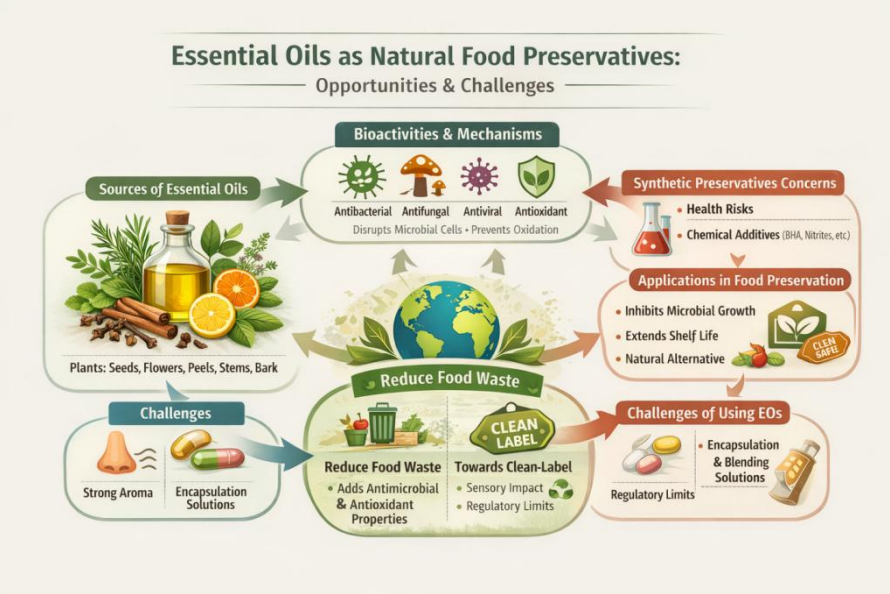
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