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Extraction of Essential Oils and Hydrosols from three Different Citrus Peels and Evaluation of their Antimicrobial and Antioxidant Activities

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Abstract

Citrus fruits are among the most processed ones into products such as beverages, jams, canned fruits, leading to a vast amount of waste (around 50-60% of the total weight of the fruit) (Wedamulla et al., 2022). Therefore, many attempts have been made to valorize citrus waste to provide value-added, bioactive components, including essential oils, flavonoids, and pectin. Conventional methods as well as novel ones, such as ultrasound-, microwave-, or enzyme-assisted extraction have been reported, where both yield and bioactivity of the components were shown to be improved by novel methods (Rifna et al., 2023). Citrus essential oil is a complex structure with d-limonene being the dominant component, in terms of both concentration and bioactivity (Siddiqui et al., 2022). These oils are reported to have antioxidant, anti-inflammatory, analgesic, antimicrobial, and anticancer activities (Singh et al., 2021). The present study aimed (i) to extract essential oils and hydrosols from grapefruit, mandarin and lemon peels by enzyme assisted/unassisted hydrodistillation and (ii) to evaluate and compare the antimicrobial and antioxidant activities of extracted compounds. The essential oil extraction yield was increased from 0.6-0.8% to 0.9-1.2% by implication of enzymatic treatment before hydrodistillation, in line with previous attempts (Chávez-González et al., 2016; Ramos-Ibarra et al., 2021; Waheed et al., 2020). As a result of well diffusion assay, the antimicrobial activities of hydrosols against Escherichia coli ATCC 25922 and Staphylococcus aureus ATCC 25923 were found to be lower than essential oils. While lemon essential oil obtained by unassisted method showed strong antimicrobial activity with minimum inhibitory concentration and minimum bactericidal concentration values of 4-16 mg/mL and 8-16 mg/mL, respectively, Staphylococcus aureus ATCC 25923 was found to be the resistant culture for most of the essential oils. Furthermore, both essential oils and hydrosols were screened for antioxidant activity with DPPH (2,2-diphenylpicrylhydrazyl) free radical-scavenging and CUPRAC (Cupric Reducing Antioxidant Capacity) methods, and their total phenolic contents were determined by the Folin-Ciocalteu method. The highest total phenolic component concentration was found in mandarin hydrosols obtained by enzyme assisted extraction (73,9 mg GAE/L hydrosol), whereas grapefruit oil and hydrosol, both obtained by enzyme assisted method, had the highest antioxidant activity with respect to CUPRAC and DPPH methods, respectively

(36,05 mg TE/g oil and 3,84 mg TE/L hydrosol). In conclusion, the extracted essential oils and hydrosols having antimicrobial and antioxidant activities are considered as interesting candidates for utilization in several industries while contributing to sustainability.

Keywords: Citrus waste; Essential oil; Enzyme-assisted extraction; Antimicrobial activity; Antioxidant activity

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