

## Alkaline extraction of phenolic compounds from Eucalyptus leaves: influence on antioxidant and antimicrobial activity

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### Topic: Environmental Microbiology & Biotechnology

#### ABSTRACT

**Background:** The valorization of agro-industrial by-products is a strategic approach to reducing biomass waste while advancing circular bioeconomy practices. Eucalyptus leaves, an abundant residue from the forestry and pulp industries, are particularly rich in phenolic compounds with well-known antioxidant and antimicrobial activities. These bioactivities highlight the potential of eucalyptus extracts for sustainable applications in the cosmetic and textile industries. However, their efficient recovery requires optimized extraction methodologies capable of disrupting the complex plant matrix and maximizing compound release. In this work, we explored alkaline extraction, focusing on the influence of particle size and alkali concentration on the recovery of phenolic-rich extracts with bioactive potential.

**Methods:** Eucalyptus leaves were processed at two particle sizes (4 mm and 10 mm) and extracted using NaOH at two concentrations (0.1 M and 0.3 M). Extracts were analyzed for total phenolic and flavonoid content as well as antioxidant capacity using ORAC assay. Phenolic composition was characterized by LC-ESI-QqTOF-HRMS. Furthermore, the antimicrobial efficacy of the extracts was tested against different Gram-negative and Gram-positive bacteria as well as the yeast *Malassezia furfur*. Additionally, the biocompatibility of the extracts was evaluated on a human keratinocyte cell line (HaCaT).

**Results:** Smaller particle sizes (4 mm) combined with lower NaOH concentrations (0.1 M) yielded extracts with higher total phenolic and flavonoid content. In terms of antioxidant activity, no significant differences were observed between the different extracts. LC-ESI-QqTOF-HRMS analysis revealed the presence of phenolic acids (e.g., quinic and gallic acid) and flavonoids (e.g., quercetin-3-O-glucuronide) with compositional differences across conditions. All extracts displayed strong antimicrobial activity against Gram-positive bacteria and *M. furfur*, with MIC values below 1.25 mg/mL in most cases. However, cytotoxicity assays indicated reduced HaCaT viability at concentrations  $\geq 500$   $\mu\text{g/mL}$ .

**Conclusions:** Alkaline extraction proved effective for recovering phenolic compounds from eucalyptus leaves, yielding extracts with strong antioxidant and antimicrobial activities. These findings support their potential for skin-related applications, including cosmetics and functional textiles, although further optimization of extraction conditions and safety thresholds is required.