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Short communication

Toxicological profile of lavender essential oil: use and concerns

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Introduction

Lavender (*Lavandula angustifolia* Mill.) is a prominent medicinal and aromatic plant widely used in the pharmaceutical and cosmetic industries (Crișan et al., 2023). Valued for its antioxidant and sedative properties, lavender essential oil (EO) is commonly applied in phytotherapy and aromatherapy for stress and insomnia (Dobros et al., 2022; Kuriyama et al., 2005). Due to its high accessibility, lavender EO is frequently used by non-professionals to create self-prepared topical formulations, such as massage oils. However, as the chemical composition of lavender EO can vary significantly depending on cultivation conditions and extraction methods, these unregulated products may pose unknown health risks (Crișan et al., 2023; Todorova et al., 2023). This study aims to characterize the chemical constituents of home-grown lavender EO and evaluate the dermal exposure and toxicological safety of its application in a 1.9% self-prepared massage oil formulation.

Materials and methods

Oil isolation and analysis

EO was isolated via 2-hour hydrodistillation (Clevenger-type apparatus) from *L. angustifolia* flowers harvested in Mislođin (Serbia) in September 2023. Chemical profiling was performed using GC-FID and GC-MS (Agilent 6890N/5975 MSD) with an HP-5MS column. Constituents were identified based on retention indices (relative to C8–C40 n-alkanes) and mass spectra comparison with NIST, AMDIS, and literature.

Formulation and hazard classification

A massage oil (1.9% w/w) was prepared by mixing 20 drops of lavender EO with 50 ml of argan oil. Hazard identification followed CLP Regulation using the ECHA C&L Inventory database.

Exposure modeling

Dermal exposure was simulated using ConsExpo Web software. Parameters were set to 8 g of product per event, application frequency of 24 times/year, and an exposed surface area of 16,300 cm².

Results and discussion

The GC-MS analysis of lavender EO isolated from lavender grown in Mislođin identified 16 constituents. The chemical profile was characterized by high proportion of oxygenated monoterpenes (75.81%) and monoterpene hydrocarbons (22.91%). The dominant constituent was *cis*-linalool oxide (40.99%), followed by *α*-campholenol (18.52%) and

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myrcene (14.85%). Other identified components included camphor (7.71%), 1,8-cineole (2.78%), linalool (2.80%), and linalyl acetate (0.59%).

When compared to the *European Pharmacopoeia* (Ph. Eur. 11) requirements for *Lavandulae aetheroleum*, the home-grown EO exhibited significant deviations. The Ph. Eur. mandates linalool (20–45%) and linalyl acetate (25–47%) as primary markers, which were more than ten times lower in the analyzed sample. Furthermore, camphor (7.71%) and 1,8-cineole (2.78%) exceeded the maximum limits of 1.2% and 2.5%, respectively (European Pharmacopoeia, 2019). High camphor levels in lavender grown in Serbia (up to 17.1%) have been previously reported by Šarić et al. (2014), while Kara and Baydar (2012) also noted significant chemical variability in lavender cultivated under different environmental conditions, supporting the unconventional profile of this sample.

Following the preparation of the self-formulated massage oil, the concentration of individual constituents in the final product was determined. The major component, *cis*-linalool oxide, was present at 0.78% in the formulation, while *α*-campholenol and myrcene were present at 0.35% and 0.28%, respectively. Potentially irritating components like camphor and 1,8-cineole were diluted to 0.15% and 0.053% in the final product.

Per CLP/ECHA criteria, the 1.9% formulation is not classified as a health hazard. Cumulative skin and eye irritants (*cis*-linalool oxide, camphor, myrcene) remained well below the 10% limit, while individual sensitizers (linalool, 1,8-cineole) were significantly under the 1% Category 1/1B threshold.

Dermal exposure modeling in ConsExpo provided specific dose data for a single massage event. For the dominant constituent, *cis*-linalool oxide, the calculated external dose per event was 9.1×10^{-1} mg/kg bw. Linalool, resulted in an external dose of 6.2×10^{-2} mg/kg bw. These values are significantly lower than the established No Observed Adverse Effect Level (NOAEL) for linalool of 250 mg/kg/day (Bickers et al., 2003). While non-standardized oils may contain oxidation products with higher sensitization potential, the 1.9% concentration used in this study represents an acceptable health risk for the general population under simulated real-use conditions.

Conclusion

Home-grown lavender EO showed a chemical profile markedly deviating from Ph. Eur. 11 standards. Nevertheless, CLP classification and ConsExpo exposure modeling confirmed that a 1.9% massage oil formulation poses no significant dermal health risk to the general population under simulated conditions. Caution remains advisable for sensitive individuals, given the variability inherent to non-standardized botanical products.

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