Abstract

Ultrasonic essential oil diffusers (EODs) are a popular type of indoor scenting source. We performed a chamber study in which we measured the emissions from EODs used with lemon, lavender, eucalyptus, and grapeseed oils. Over the course of 15 min, the most abundant VOCs released from lemon, lavender, eucalyptus, and grapeseed oils were 2.6 ± 0.7 mg of d-limonene, 3.5 ± 0.4 mg of eucalyptol, 1.0 ± 0.1 mg of linalyl acetate, and 0.2 ± 0.02 mg of linalyl acetate, respectively. Each oil had a unique particulate matter (PM) emission profile in terms of size, number density, and rate. The dominant size ranges of the PM were 10–100 nm for lemon oil, 50–100 nm for lavender oil, 10–50 nm for lemon oil, and above 200 nm for grapeseed oil. PM_1 emission rates of approximately 2 mg/h, 0.1 mg/h, and 3 mg/h, were observed for lemon, lavender/eucalyptus, and grapeseed oils, respectively. A fivefold increase in PM_1 emission was measured when the EOD with eucalyptus oil was filled with tap water as opposed to deionized water. Modeling suggests that reasonable use cases of EODs can contribute substantially to primary and secondary PM in indoor environments, but this potential varies depending on the oil and water types used.

Main findings

- Essential oil diffusers emit **large quantities** of VOCs and particulate matter.
- Essential oil **type** impacts the **amount** and **size distribution** of emitted particulate matter and the amount and VOC fingerprint.
- Using **tap**, rather than distilled water, in a diffuser leads to much higher emissions of particulate matter.
- Essential oil diffuser emissions can greatly increase indoor concentrations of fine particulate matter.
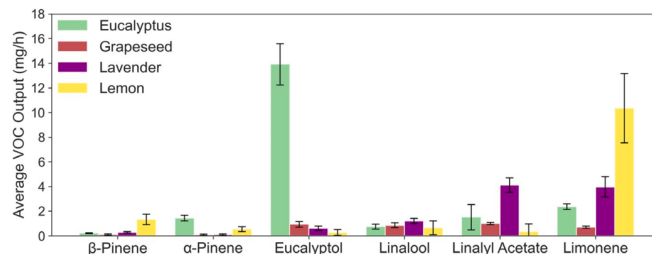
Figure 1. Average volatile organic compound (VOC) outputs (converted from data over 15 min) for lemon, eucalyptus, lavender, and grapeseed oils. Error bars represent the standard deviation in output across 3 trials.
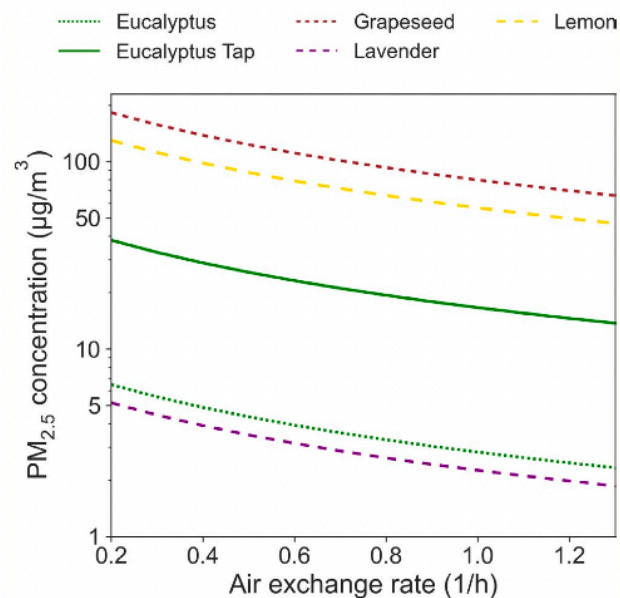

Figure 8. Estimated indoor $PM_{2.5}$ concentration due to the use of an essential oil diffuser under varied air change rates. Dashed lines indicate expected concentrations when the diffuser is filled with deionized water, and solid lines indicate expected values when the diffuser is filled with tap water.