



TOXPOINT

Alternative Flavored Inhalable Products—A New Respiratory Hazard?

Alayna P. Tackett ^{*,†,1} and Meghan E. Rebuli ^{‡,§}

*Department of Population and Public Health Sciences, Keck School of Medicine, University of Southern California, Los Angeles, CA 90089, USA; [†]Health, Emotion & Addiction Laboratory, Institute for Addiction Sciences, University of Southern California, Los Angeles, CA90089, USA; [‡]Center for Environmental Medicine, Asthma, and Lung Biology, Department of Pediatrics, School of Medicine, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599, USA; and [§]Curriculum in Toxicology & Environmental Medicine, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599, USA

¹To whom correspondence should be addressed at Department of Population and Public Health Sciences, Keck School of Medicine, University of Southern California, 2001 N. Soto Street, Los Angeles, CA 90089, USA. E-mail: Alayna.Tackett@usc.edu

Key words: inhalation; essential oils; toxicity; e-cigarette; flavoring.

A new category of inhalable devices—inhaled essential oils (eg, Füm, Monq)—have emerged which appear to capture users interested in flavored, inhalable products like e-cigarettes, but do not contain nicotine or tobacco. Many of these products utilize health-oriented language (eg, “organic,” “natural”) to describe these products. Packaging and promotional materials using health-oriented language can influence users’ perceptions of harm (Pearson *et al.*, 2017; Sanders-Jackson *et al.*, 2018) associated with products and using this language can increase product appeal (Pearson *et al.*, 2017; Sanders-Jackson *et al.*, 2018). This is potentially problematic and concerning from a public health view, as these products have not undergone toxicity or clinical effectiveness evaluation.

Many of these inhaled essential oil devices utilize suggestive marketing techniques that certain products are a “safer alternative to vaping [e-cigarettes],” use “super plants” to help “quitting smoking naturally,” are a “healthier, cleaner” product to “provide a sense of well-being,” and alter your “respiratory diet.” Specifically, black pepper, peppermint, and lavender flavors are marketed as an aid to reduce nicotine cravings, improve breathing, and calm pain associated with nicotine/tobacco cessation. Although there is some limited evidence that flavoring com-

pounds in essential oils may have benefits for nicotine cessation, there has been minimal investigation into the validity of essential oil use and the reduction of subjective ratings of nicotine craving claims. Specifically, the 2 studies (Cordell and Buckle, 2013; Rose and Behm, 1994) found in the extant literature are extremely limited in scope, evaluated only short-term subjective symptoms, no respiratory endpoints were included, and the effects on long-term nicotine cessation were not evaluated (Rose and Behm, 1994). Thus, caution and intense further study are warranted prior to recommending use for nicotine cessation.

These inhalable device products claim to differ from e-cigarettes in the inclusion of only essential oils; however, manufacturing is not strictly regulated, so the inclusion of additives or contaminants is possible. Other similarities to e-cigarette devices include use of vegetable glycerin as a humectant, electronic product designs, and appealing flavors, which have been previously shown to attract adolescent use. These products may be plant based and naturally derived, but the safety of inhalation of flavoring compounds included has not yet been evaluated. What is known is that ingestion of essential oil products has led to an uptick in poison control calls (Gummin *et al.*, 2020), as ingesting even a few milliliters can cause nausea and

vomiting. While some of these products still include electronic components to “vaporize” (aerosolize) the oils, some have moved to non-electronic passive diffusion designs (ie, Füm).

There is a broad literature suggesting that flavoring compounds like black pepper, cinnamon, vanilla, lemon/lime, mint, fir/pine, and eucalyptus contribute to airway toxicity, specifically, impaired respiratory immune cell function, cytotoxicity, and increases in oxidative stress (Hickman et al., 2019). Furthermore, room diffused essential oils, including lavender, eucalyptus, and tea tree have also been previously found to release known hazardous chemicals, such as terpenes, toluene, and benzene (Chiu et al., 2009; Su et al., 2007), which can cause respiratory symptoms including breathlessness and respiratory hyper-responsiveness in people with and without asthma (Chiu et al., 2009; Su et al., 2007). Lavender and tea tree oils may also act as endocrine-disrupting compounds, disrupting hormonal homeostasis (Ramsey et al., 2019). Finally, allergic sensitization is also a common side effect of dermal use of essential oils, including around the mouth, which would be a point of contact for these types of devices. The primary benefits of aromatherapy have been shown with inhalation at very low doses (eg, through room-based diffusers, candles, etc.). Thus, inhalation of large doses of flavoring compounds included in essential oils may result in toxicity, which manifests in malfunctioning immune cells, epithelial inflammation, and altered mucus production, effectively compromising the ability of the lung to protect the body from inhalational hazards and pathogens.

At present, the lack of inclusion of nicotine or other tobacco-based component in these essential oil inhalation devices limits the ability of the Food and Drug Administration to regulate or evaluate the safety of these types of devices through the Deeming Rule which allowed regulation of e-cigarettes. Thus, there is a continuing need to complete toxicity and health effects testing in the ever-expanding inhalable device market and to characterize flavorings and humectants present in new devices. Furthermore, awareness of these products by physicians, parents, and educators is needed to avoid adolescent adoption of untested alternative inhalable flavored devices to reduce the potential for long-term health hazards due to flavoring chemical-based respiratory toxicity.

FUNDING

Research reported in this publication was supported by the National Heart, Lung, and Blood Institute (K01HL148907; A.P.T.) and the National Institute of Environmental Health Sciences of the National Institutes of Health (P30ES010126; T32ES007126; M.E.R.). The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH or the FDA.

DECLARATION OF CONFLICTING INTERESTS

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

ACKNOWLEDGMENTS

The graphical abstract was created using BioRender.com.

REFERENCES

- Chiu, H. H., Chiang, H. M., Lo, C. C., Chen, C. Y., and Chiang, H. L. (2009). Constituents of volatile organic compounds of evaporating essential oil. *Atmos. Environ.* **43**, 5743–5749.
- Cordell, B., and Buckle, J. (2013). The effects of aromatherapy on nicotine craving on a US campus: A small comparison study. *J. Altern. Complement. Med.* **19**, 709–713.
- Gummin, D. D., Mowry, J. B., Beuhler, M. C., Spyker, D. A., Brooks, D. E., Dibert, K. W., Rivers, L. J., Pham, N. P. T., and Ryan, M. L. (2020). 2019 Annual report of the American Association of poison control centers’ National Poison Data System (NPDS): 37th annual report. *Clin. Toxicol.* **58**, 1360–1541.
- Hickman, E., Herrera, C. A., and Jaspers, I. (2019). Common e-cigarette flavoring chemicals impair neutrophil phagocytosis and oxidative burst. *Chem. Res. Toxicol.* **32**, 982–985.
- Pearson, J. L., Johnson, A., Villanti, A., Glasser, A. M., Collins, L., Cohn, A., Rose, S. W., Niaura, R., and Stanton, C.A. (2017). Misperceptions of harm among Natural American Spirit smokers: Results from wave 1 of the Population Assessment of Tobacco and Health (PATH) study (2013–2014). *Tob. Control* **26**, e61–e67.
- Ramsey, J. T., Li, Y., Araq, Y., Naidu, A., Coons, L. A., Diaz, A., and Korach, K. S. (2019). Lavender products associated with premature thelarche and prepubertal gynecomastia: Case reports and endocrine-disrupting chemical activities. *J. Clin. Endocrinol. Metab.* **104**, 5393–5405.
- Rose, J. E., and Behm, F. M. (1994). Inhalation of vapor from black pepper extract reduces smoking withdrawal symptoms. *Drug Alcohol Depend.* **34**, 225–229.
- Sanders-Jackson, A., Tan, A. S., and Yie, K. (2018). Effects of health-oriented descriptors on combustible cigarette and electronic cigarette packaging: An experiment among adult smokers in the United States. *Tob. Control* **27**, 534–541.
- Su, H. J., Chao, C. J., Chang, H. Y., and Wu, P. C. (2007). The effects of evaporating essential oils on indoor air quality. *Atmos. Environ.* **41**, 1230–1236.