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File: ■ Essential Oils
■ Authenticity
■ Adulteration

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RE: Overview of Essential Oil Adulteration

Do TKT, Hadji-Minaglou F, Antoniotti S, Fernandez X. Authenticity of essential oils. *Trends Analyt Chem*. March 2015;66:146-157.

Essential oils refer to plant extracts usually manufactured by various distillation processes or mechanical expression, and contain aromatic and often volatile compounds. The essential oils are critical components and ingredients of the flavor, fragrance, cosmetic, aromatherapy, and medicinal plant industries. Essential oils have a high commercial value, and certain oils are produced on a small scale (e.g., iris [*Iris* spp., Iridaceae] or damask rose [*Rosa* × *damascena*, Rosaceae] oil) and can sell for over US $10,000/kg due to the scarcity of the raw material. Authentication of these oils, consisting of a multitude of compounds, is crucial for various economic and public health reasons. This review describes various techniques for authenticating these products, which is particularly challenging because of the variability in essential oils from a given species due to differences in habitat, harvesting and processing methods, and other sources of heterogeneity.

Many regulatory bodies throughout the world have created monographs designed to contain specific authentication criteria for individual essential oils. Adulteration may compromise the value of essential oils and has come from multiple causes, such as the inclusion of substitute constituents that are cheaper, the admixture of inexpensive essential oils from other natural sources, or the addition of vegetable oil or solvents like propylene glycol, triacetin, triethyl citrate, or benzyl alcohol. Since the amount of various compounds in essential oils may greatly affect the economic value of the oil, there is a monetary incentive to spike certain essential oils with synthetic isolates. For example, the addition of the compound citral to lemon (*Citrus* × *limon*, Rutaceae) essential oil may elevate the quality of the final product. Mixing synthetic α-bisabolol into a chamomile (*Matricaria recutita* syn. *Chamomilla recutita*, Asteraceae) essential oil to enhance its bioactivity may make this oil more commercially viable. Essential oils may also be adulterated for olfactory reasons. For example, lavender (*Lavandula angustifolia*, Lamiaceae) essential oil may be spiked with oil from a cheaper species. In another example, cinnamon (*Cinnamomum verum* syn. *C. zeylanicum*, Lauraceae) bark essential oil has been adulterated with oil from leaves of the plant to reduce the amount of the potentially allergenic compound cinnamaldehyde.

There are many techniques available for the detection of adulteration. Strategies include investigating the entire chemical composition (fingerprint) of essential oils or the detection and quantification of individual marker compounds. One assessment of adulteration comes from organoleptic experts, specially trained to detect variation in essential oil products. This method may take time for training and testing. Physical properties of the essential oils may also be assessed, such as refraction properties, density, optical rotation, and freezing or boiling points. Organoleptic assessments, the evaluation of physical properties, and titrations are simple and fast, but are usually unsuitable to detect more subtle cases of adulteration.

Chemical separation techniques, such as gas and high-performance liquid chromatography (GC and HPLC) or high-performance thin-layer chromatography (HPTLC), may be used to detect the presence and amounts of individual compounds or to compare chemical fingerprints. GC is especially useful for essential oil investigation, and chiral GC can further identify compounds based on their arrangement in space. Other useful techniques include isotope-ratio mass spectrometry (IRMS), which allows the determination of chemical compositions of essential oils based on carbon uptake, and nuclear magnetic resonance (NMR) spectroscopy, which has proven very powerful in confirming the identity of essential oils.

Chromatographic techniques, which are methods to separate out compounds, may be paired with mass spectrometry (MS), infrared (IR) spectroscopy, or Raman spectroscopy to improve detection and provide additional information about the compounds in the essential oil. Vibrational spectroscopy uses molecular vibrations to identify covalent bonds, and multidimensional chromatography couples various chromatography to identify compounds. Also, differential scanning calorimetry, based on the flow of heat, and thermal diffusivity are beginning to be used.

Newer data analysis options include complex statistical evaluations of the chemical analysis (chemometrics) to establish the similarity between essential oils and to identify adulteration.

In summary, the economically motivated adulteration of essential oils is an ongoing problem. It is important that the admixture of, or substitution with, cheaper ingredients is accurately detected, and there are many analytical techniques available for doing so.

—Amy C. Keller, PhD

The American Botanical Council has chosen not to include the original article.