Carbon-14 analysis: natural versus synthetic essential oil

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As consumers favour natural essential oils over synthetic alternatives, the price of essential oil escalates, mainly due to expensive production costs. The rising monetary value of plant oil tempts unscrupulous companies in the industry to produce and sell adulterated essential oils tainted with cheaper synthetic ingredients. The onus is on distributors and manufacturers downstream to identify these adulterated products before they reach the consumer market.

In many cases, it is difficult to distinguish between naturally derived ingredients and synthetic alternatives. Natural product testing through carbon-14 analysis authenticates plant-sourced ingredients while also acting as a screening tool to detect synthetic adulterants manufactured from petrochemicals.

Rising demand for essential oils poses challenges for manufacturers and distributors

Consumer preference for natural plant extracts in formulations and growing applications of essential oils in personal care, food and beverage, and aromatherapy have boosted the demand for essential oils. The global essential oil market size is increasing over time, valued at USD 6.6 billion in 2016[1] and expected to reach USD 13.94 billion by 2024, prompting distributors of essential oils to experience booming sales.[2]

Despite rising consumer demand and increasing market size for essential oils, manufacturers are facing several challenges. Since essential oils are highly concentrated plant constituents, huge quantities of raw material are needed. For example, in order to produce just one pound of oil: 1,500 lemons, 250 pounds of lavender, or 10,000 pounds of rose petals are required.[3]

Limited supplies of raw material resulting from poor weather conditions or the spread of crop disease throughout farms and plantations mean manufacturers are experiencing high and variable production costs. In response, there is also an upsurge in the market price that consumers pay for essential oil products.

In Argentina, lemon crop production has yielded 20 percent fewer lemons in 2018 compared to 2017. Natural lemon oil is a popular fragrance in many perfumes and personal care products, but high demand triggered a striking price increase of approximately 12 percent from 2017 to 2018, which may cause consumers to rethink their purchases.[4] Likewise, in Bulgaria, the largest growing area for lavender oil worldwide, 2018 production of lavender flowers fell short, elevating prices and failing to meet consumer demand for lavender oil.[5]

The combination of limited raw material, high production costs and escalating selling prices of essential oil presents a financial hurdle for manufacturers and distributors, pressuring them to produce, buy and sell cheaper essential oils that allow them to stay competitive.

Synthetic adulterants

As essential oils are increasingly difficult to source at a competitive price, manufacturers and distributors are struggling to find solutions to fulfill consumer demand. Increased production expenses and market prices for essential oils create a financial incentive to produce adulterated essential oils using more readily

available raw materials as cost-effective alternatives to raw plant extracts. Within the personal care, flavour and fragrance industries, it is common to find artificial fragrance oils in the market as substitutes to plant-based products but they may not always be labelled as such.

Fragrance oils are manufactured from mineral raw materials such as petroleum rather than plants. Labels on fragrance oil products are sometimes misleading to consumers, causing them to perceive fragrance oils and essential oils as interchangeable products. Ingredient labels on fragrance oils tend to include "nature identical" in which the term "nature" may be associated with natural ingredients when in reality it refers to "...a substance which has been prepared synthetically but which is chemically identical to a natural one."[6]

There are several additives and petrochemical-derived nature identicals frequently used to mimic essential oil products or constituents. Lavender, a favoured scent in the fragrance industry, is often added to shampoos, lotions and skin care products. Lavender oil often contains an ingredient called linalool, which may be in a natural or synthetic form. When aiming for lower production costs, manufacturers may opt to use petrochemical-derived linalool, a nature identical additive containing the same chemical makeup as pure linalool distilled from lavender plants, but of petrochemical sources rather than plant-based.[6,7] Petrochemical-derived linalool is just one of many adulterants that can be present in products labelled as "natural essential oil."

Adulteration within the essential oil industry highlights the need for transparent analytical methods such as carbon-14 testing to screen products for synthetic ingredients.

Authentication of essential oils through carbon-14 analysis

Identification of adulterated essential oils is possible through the use of analytical techniques such as carbon-14 testing, which indicates whether the origin of essential oil ingredients is natural or synthetic. Material derived from plant origin contains a known level of the radioactive carbon-14 isotope, whereas petrochemical-derived material does not contain any evidence of carbon-14. Therefore, when laboratories such as Beta Analytic use carbon-14 analysis to authenticate that an essential oil product is sourced from solely 100% plant origin, the analysis will yield results of 100% biobased. This reliable analysis for natural source testing can also identify and screen for synthetic petrochemical-derived ingredients, yielding results between 0% and 100% biobased due to the presence of petrochemical-originated ingredients, such as synthetic linalool.[8] The application of carbon-14 analysis is a reliable tool that helps stop the spread of adulterated product ingredients in the supply chain.

Conclusion

The lucrative essential oil industry continues to experience market growth as demand for essential oil escalates. However, increasing demand for essential oil creates several challenges for manufacturers. Primarily, high costs of production and insufficient raw material supplies are key drivers behind the production of cheaper fragrance oils comprised of synthetic ingredients. With the possibility that essential oils containing synthetic constituents are labelled "natural," it is necessary to apply the use of carbon-14 analysis to distinguish between pure plant and petrochemical-derived essential oils. PC

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