How Biotechnology is Disrupting the Musk Fragrance Industry

By Katherine Oglesby

There's something magical about musk. Its scents are warm, inviting, and powerful in the emotions it helps to evoke. It signals intimacy, whether between a mother and child or between lovers. It can convey safety or adventure. Enchanted by its effects, humans have sought and used musk for centuries, in a wide variety of applications, from traditional medicine to fragrances. And today, not much has changed. Musk scents are found in many personal care and household products, including soaps, air fresheners, and scented candles, adding a boldness that elevates all of the other scents present.

Like other magical materials, how musk was conventionally sourced is distressing. Musk was first discovered in animals, including the musk deer, civet cat, and others. It was extracted from them in a cruel way that often resulted in their death. Today's market for animal musks is almost extinct and natural musk is primarily plant-based, sourced from ambrette (musk mallow) seeds and Angelica root. Sourcing from plants is less barbaric and more ethical, yet very expensive, making fragrances with musk more of a luxury product, inaccessible to average consumers.

On to Synthetic Musks

The intense desire for musk was satiated by the rise of synthetic chemistry in the early 20th century. At first, fragrance companies used these techniques to synthesize natural musk. Over time, chemists also discovered new musk molecules. Molecules that were once rare became abundant and inexpensive to produce on a massive scale. Synthetic musk, including nitro musk, polycyclic musk, macrocyclic musk, and others, were quickly adopted by formulators. Today, the vast majority of modern fragrances use synthetic musk.

While cost and availability are important traits, synthetic musks have some undesirable features. Musk fragrances are largely petroleum-based hence reliant on fossil fuels, a characteristic that is incongruent with the growing consumer demand for more natural and sustainable products.

In addition, there has been a growing body of scientific literature detailing the accumulation and effects of synthetic musk in the environment.[1] Moreover, there's evidence that nitro musks

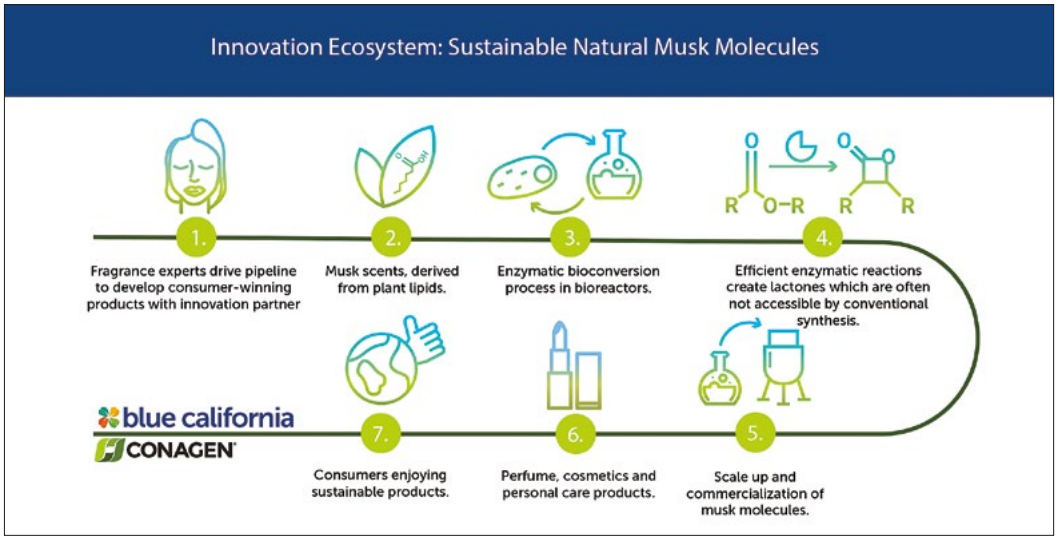

Figure 1.
The production process for bio-based musk.

are toxic to marine and terrestrial organisms. They can also accumulate in human tissues and, while little is known about the physiological effects of human exposure, regulatory bodies haven't waited for definitive studies.[2] Some nitro musks have been banned in the EU and Japan and the use of nitro musks is prohibited or limited by the International Fragrance Association.

Production of other synthetic musks, like macrocyclic musks, has increased to take the place of the nitro musks, yet their production is just as unsustainable, leaving a big gap in the desires of consumers and capabilities of synthetic chemists.

Biotechnology Solutions for the 21st Century: Building a More Accessible, Sustainable Musk

Despite these challenges, there is still demand for the intoxicating, intimate, and bold scents of musk. And there are new, inventive approaches: Using bioengineering and biotechnology to build the future of fragrances. Sensegen (Rancho Santa Margarita, California) and Conagen (Bedford, Massachusetts) are creating an innovation ecosystem where this approach thrives, marrying fragrance expertise and biotechnology excellence to create powerful synergy, enabling us to tackle the biggest unmet needs of the industry.

Bioengineering allows the manipulation of living organisms to produce high-value compounds. Recently, Conagen has used these methods to develop a bio-based pathway for the conversion of plant-derived lipids into macrocyclic gamma-lactones, a type of musk that has been difficult to produce using chemistry (Figure 1). In partnership with Conagen, we are collectively shifting the fragrance market into a more sustainable space. Conagen's discovery and manufacturing platform are built on proprietary biotechnology and the biological process is relatively low-cost, highly scalable, and uses sustainable feedstocks, not petroleum-based starting materials.

While scale-up of macrocyclic gamma-lactones is underway, our team at Sensegen is transforming this powerful R&D into modern, eco-friendly solutions for a full range of products that all types of consumers can enjoy. And we continue to bring market expertise to our innovation ecosystem with Conagen, who is poised to discover bioprocesses for many more magical fragrances and flavors.

References

1. *Wong F, Robson M, Melymuk L, et al. Urban sources of synthetic musk compounds to the environment. Environ. Sci.: Processes Impacts. 2019;21:74-88.*
2. *Taylor KM, Weisskopf M, Shine,J. Human exposure to nitro musks and the evaluation of their potential toxicity: an overview. Environ Health. 2014;13:14.*

Katherine Oglesby is an executive senior scientist and business leader of Sensegen™, the flavor and fragrance division at Blue California, the industry's first forward-integrated biotechnology-based flavor and fragrance business. Kathy has worked in global leadership roles for large international companies covering business development and sustainability for food, flavor, fragrance, and biotechnology companies, including The Coca-Cola Company, Evonik (formerly Degussa), Firmenich, and Amyris.

https://bluecal-ingredients.com/portfolio/flavors-and-fragrances/