January 2023
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The Resource for Sensory & Wellness Innovation



Part 2: Application of Gas-Liquid Chromatography to the Analysis of Essential Oils

The Power of Scent

Read the latest innovations linking scent and well-being on page 24.

The Future of AI x Fragrance

Flavor Trends: Exploring the World of Middle Eastern Cuisine

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WHERE THE WORLD COMES TO ITS SENSES

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Welcome to F&F's Next Chapter



Artificial intelligence and virtual reality have been growing buzzwords in F&F. Take a look into the future on page 24.

What will 2023 bring to the F&F industry? The global flavors and fragrances market is projected to grow from $26.54 billion in 2022 to $36.49 billion by 2029, at a CAGR of 4.7% in forecast period. *Perfumer & Flavorist+* (*P&F+*) is ready to find out the next wave of innovation in technology, evolving consumer demands, regulatory updates and launches from F&F companies across the globe.

The industry has been buzzing with news of advances in artificial intelligence (AI) and virtual reality experiences for consumers. After attending the *World Perfumery Congress* 2022, fragrance consultant, Olivia Jezler, penned a column on how the event provided a preview of a sensory future combining human expertise and computing precision. Readers can discover her findings on **page 24**.

Another growing relationship is between fragrance and well-being. Explore the recent platforms for research by F&F companies as well as products debuting on shelves around the world designed to tap into mental health and well-being on **page 32**.

On the flavor side, be sure to mark your calendar for *Flavorcon* 2023, scheduled to return to the Duke Energy Convention Center in Cincinnati, November 8-9. More details to come on the upcoming event as it grows closer. Expect an off-site networking event, a loaded expo hall and a slew of fresh conference sessions. Until then, you can discover a recap of last year's edition on **page 40**.

The January issue also celebrates the latest additions to *P&F+*'s advisory board (**Page 42**), with two of our members highlighted in the Profiles section (**Pages 10**). With the help of our advisory board, we plan to continue providing the most relevant and inspiring content for F&F professionals. If you have a pitch for a guest column or would like to weigh in on a topic, please send an email to jrimensnyder@allured.com.

[a]*www.fortunebusinessinsights.com/flavors-and-fragrances-market-102329*



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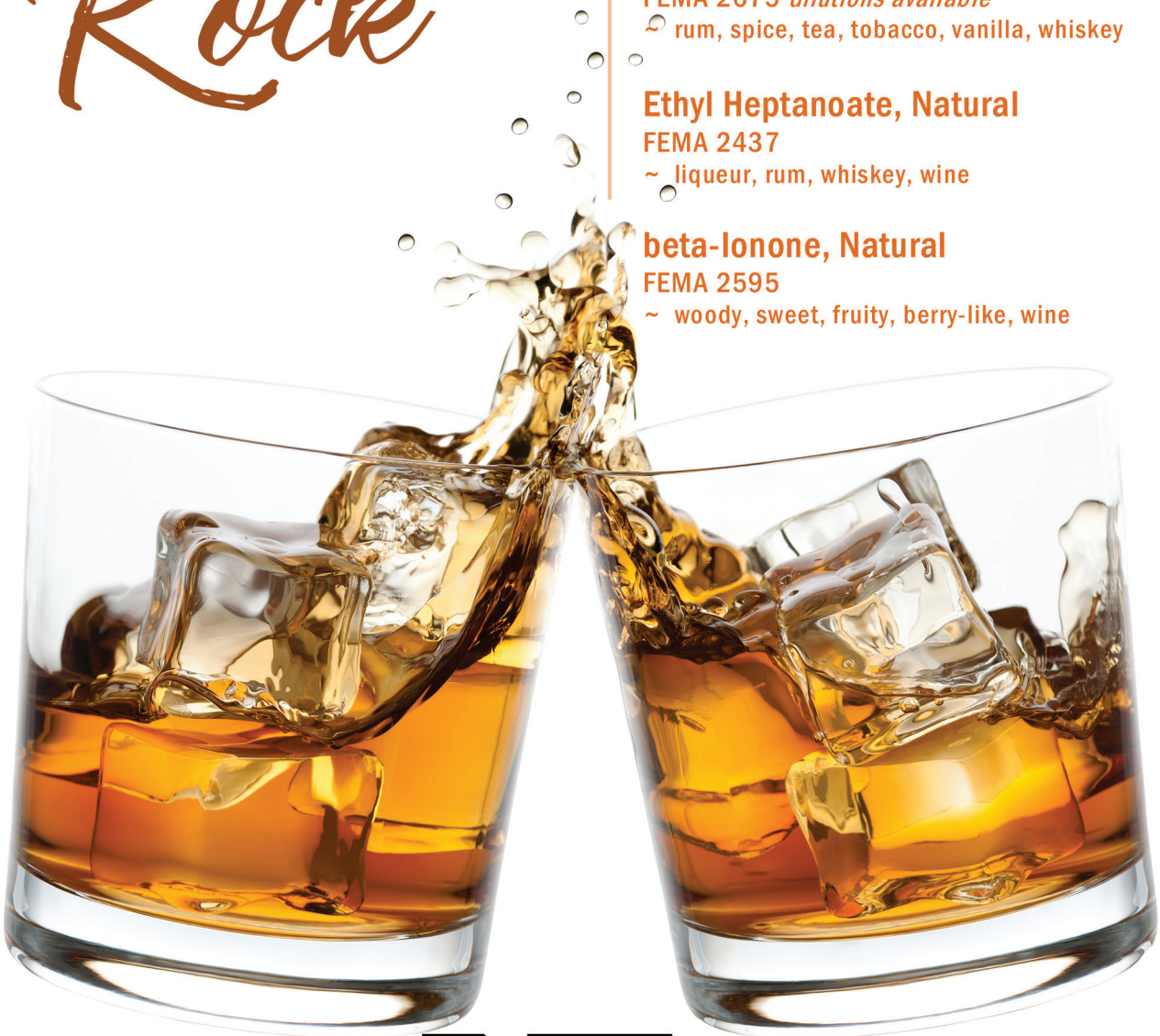
p-Cresol, Natural
FEMA 2337 *dilutions available*
~ rum, smoke, vanilla, whiskey

Phenylacetaldehyde, Natural
FEMA 2874 *dilutions available*
~ honey, rose, wine, fruit, grape

2-Methoxy-4-vinylphenol, Natural
FEMA 2675 *dilutions available*
~ rum, spice, tea, tobacco, vanilla, whiskey

Ethyl Heptanoate, Natural
FEMA 2437
~ liqueur, rum, whiskey, wine

beta-Ionone, Natural
FEMA 2595
~ woody, sweet, fruity, berry-like, wine



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Ingredients and Equipment



Vanillin isobutyrate natural, ≥98%, FG

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We invite you to experience our listing of vanillin isobutyrate natural (FEMA# 3754, CAS# 20665-85-4). This ingredient has a sweet profile of vanilla and nutmeg. It is certified food grade, halal, kosher, natural, follows IFRA guidelines and meets purity specifications of JECFA. Contact us at ff@milliporesigma.com for a free sample.



HiPer Ginger

Lionel Hitchen

www.lionelhitchen.com/hiper-spices-range/

We handle the mess, you get the pleasure of the whole ginger root experience. Our HiPer Ginger (FEMA#2523, CAS#84696-15-1) is manufactured using multiple process steps to remove the insoluble parts, resulting in an enhanced flavor profile, low color and an excellent ingredient for beverage flavors.



Fragolane

Symrise AG

www.symrise.com/de/scent-care/aroma-molecules/ingredient-finder/#Fragolane

Fragolane (FEMA# 4294, CAS# 6290-17-1) comes with sweet anisic and fennel notes and a deep fruity character. It contributes body and sweetness to nearly all fruit flavors. It underlines herbal and spicy notes. It works in meat and onion flavors, like plant-based food products, adding juiciness. Besides strawberry, it finds use in perfumery.



Trimethylamine

Natural Advantage

www.natadv.com

Natural Advantage introduces natural trimethylamine (FEMA #3241, CAS # 75-50-3). Natural trimethylamine occurs naturally in beer and cocoa, but most importantly in fish, where it gives that fishy taste and odor. Other uses are seafood and pork. Natural trimethylamine can be used in fruit flavors at low levels to impart a pulpy flesh impression. Available in water soluble and oil soluble, and low odor trimethylamine at 25%. Used at 0.001 ppm to 0.1 ppm as consumed. EU and U.S. natural, kosher, non-GMO, vegetarian.

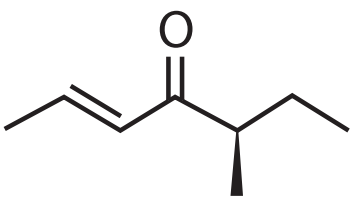


Lemongrass Oil East Indian

Berjé

https://www.berjeinc.com/products/essential-oils/lemongrass-oil-east-indian/

Lemongrass oil has an intensely strong and fresh aroma, with grassy and herbaceous overtones paired with a lemony-citrus nuance. Lemongrass is iconic for its high citral content, which imparts a clean and tenacious odor that can retain its strength for upwards of 72 hours.



EU Natural Filbertone 98%, Chiral

Oamic Ingredients LLC

www.oamicus.com

Natural filbertone (FEMA# 3761, CAS# 81925-81-7) has aroma characteristics at 1.0% of sweet roasted hazelnuts and a rich, nutty nuance with a roasted nut skin. Taste characteristics at 5 ppm are nutty, roasted, coffee, cocoa, brown with an earthy and meaty nuance, sugar fondant, delicate, hazelnut, with macadamia and pecan nuances.



Natural Nootkatone 70

Isobionics

www.isobionics.com/global/en/product-finder/natural-nootkatone-70.html

Isobionics Natural Nootkatone 70 (FEMA# 4941, CAS# 4674-50-4) has a dry cedar, woody and grapefruit cedar, incense and sandalwood taste. With 70% purity, the product is suitable for a broad range of applications such as beverage formulations. Due to our cutting-edge fermentation technology we guarantee premium quality and reliable availability. It is EU and U.S. natural, pesticide-free, food grade, kosher and halal certified.



Tournaire's extra-large opening O220

Tournaire

www.tournaire.fr/en/emballages/o200-2

The Tournaire monobloc O220 range offers an extra-large opening while guaranteeing optimal tightness. With controlled chemical, microbiological and particle cleanliness, it is used to store and ship sensitive products such as jasmine and rose concrete, iris butter and many more. Feel free to email us at contact@tournaire.fr for more information.

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INDUSTRY INSIGHTS:

Mouthfeel & Sugar Alternatives

Industry experts weigh in on how to map out mouthfeel when formulating sugar alternatives.

Featured Insiders:

- Icon Foods
- Sensient



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The global sugar substitutes market[a] was valued at $6.22 billion in 2021 and is expected to expand at a compound annual growth rate of 5.9% from 2022 to 2030, according to Grand View Research. According to the report, the COVID-19 pandemic influenced the demand for healthier products as people became more conscious about their eating habits and the importance of leading a healthy lifestyle. With the growing demand and innovation in functional food and beverage items, we've tapped industry experts on the trends, challenges, and potential opportunities when considering mouthfeel when formulating with sugar alternatives.

Thom King, CEO, Icon Foods

***Perfumer & Flavorist*+ [*P&F*+]: What are some of the current application focuses of the mouthfeel innovation market?**

Thom King [TK]: Smoothies and beverages where the mouthfeel of sugar is desired. Ingredients like FOS (fructooligosaccharides), inulin and soluble tapioca fiber can emulate fats and deliver lower viscosity, giving beverages a richer, fuller mouthfeel closer to sugar. Unlike hydrocolloids (such as xanthan gum, locust bean gum, etc.), fibers do not need to be activated by heat. This is particularly important with products that are packed at ambient temperatures.



Thom King

***P&F*+: From your perspective, what are the more difficult applications when considering mouthfeel? Why?**

TK: As above, ready-to-drink (RTD) beverages because consumers are expecting a fuller experience like those delivered by full sugar drinks. Stevia, erythritol and monk fruit do not contribute to mouthfeel and can be perceived as thin.

***P&F*+: What are the evolving consumer demands you're seeing?**

TK: Prebiotic fibers. Consumers understand that the microbiome is responsible for the majority of the immune system. The microbiome feeds on prebiotic fibers such as inulin, FOS, soluble tapioca fiber and stacking these fibers in formulas and increases the positive impact.

***P&F*+: Any untapped potential or opportunities in the mouthfeel innovation market?**

TK: I believe we will see more interesting fibers in the future. These will come from bioconversion and various plant material. They will impact the microbiome in various ways while providing texture and mouthfeel.

Whitney Johnson, beverage applications manager, Retail/QSR Group, Flavors & Extracts, Sensient

***P&F*+: What are some of the current application focuses of the mouthfeel innovation market?**

Whitney Johnson [WJ]: We are seeing a lot of requests in the alcohol and non-alcohol beverage space to create a fuller mouthfeel in products with lower sugar. While these products aren't considered to be diet products, they are being developed with a lower amount of sugar to start (between 0-4%). Consumers are still expecting a full-flavor experience with lower sugar products, but building that back in can be difficult when brands are looking to make cleaner/shorter ingredient statements.



Whitney Johnson

***P&F*+: From your perspective, what are the more difficult applications when considering mouthfeel? Why?**

WJ: Nutritional/functional products are most challenging to develop when trying to create the right mouthfeel. Protein ingredients can vary greatly in the attributes they bring to a product, affecting thickness, astringency, etc. While some proteins create a lot of thickness or viscosity in a product, it may be undesirable. Other proteins though, may not change the texture enough and then the end product needs to be thicker. It's important to first have a good understanding of your ingredient source (e.g., animal or plant protein) and how to blend and adjust the source to get a good mouthfeel

[a] *bit.ly/3OJGsOu*

base. Once this is solidified, working with the right flavor and modifier system to optimize the product for an optimal taste experience is key.

***P&F+*: What are the evolving consumer demands you're seeing?**

WJ: We're receiving a lot of requests for low-calorie, low sugar and no-artificial ingredients. With the recent volatility in the supply chain market, we also have customers who are looking to replace thickeners or enhance mouthfeel because the ingredient they were using to create this has longer lead times or isn't available.

***P&F+*: What are the trends driving these demands?**

WJ: Supply chain issues have been a big challenge for the food industry in the past year. Customers are trying to keep their plants full and shelves stocked and are looking for alternate and creative ways to solve these issues. We have also seen many brands make commitments to their consumers saying they will lower sugar or have no artificial ingredients by a certain date. We have had success in addressing these issues with minimal impact to the label and cost of the product, enabling our customers to continue manufacturing their products and stay true to their commitments.

***P&F+*: Any untapped potential or opportunities in the mouthfeel innovation market?**

WJ: We often think of innovation in mouthfeel as it relates to making the product taste better and cleaner, but I think there's also a big opportunity for cost savings. With the volatility of the market and bulk commodities, replacing part of a formulation with a mouthfeel technology ingredient could help reduce the cost of the formulation, as well as any costs associated with freight/shipping.



Perfumer Offers Insight into Sold Out Elon Musk's Burnt Hair Fragrance

When billionaire entrepreneur Elon Musk announced his fragrance that was created to smell like burnt hair, the internet went wild. News of the fragrance went viral and upon the release of "Burnt Hair," a scent for men by Singed, sold out immediately. But what makes consumers so intrigued by this scent? Is it actually worth the wear or is it just to acquire a piece of pop culture?

Sold on *boringcompany.com*, the fragrance, also referred to as "The Essence of Repugnant Desire," hosted the following quotes posed as reviews:

- "Just like leaning over a candle at the dinner table, but without all the hard work."
- "Stand out in a crowd! Get noticed as you walk through the airport."



Perfumer & Flavorist+ *reached out to Firmenich senior perfumer (and* World Perfumery Congress *2022 speaker), Frank Voelkl, to discuss the nuances of the fragrance and what, if anything, this scent says about the trends of the market.*

Perfumer & Flavorist+ reached out to Firmenich principal perfumer (and *World Perfumery Congress* 2022 speaker), Frank Voelkl, to discuss the nuances of the fragrance and what, if anything, this scent says about the trends of the market. While Voelkl did not have a hand in the fragrance, he offered his insight into the interesting formulation.

***P&F+*: From your perspective, why are people so attracted to something like this?**

Frank Voelkl [FV]: Scents that are different, interesting and even a bit weird don't always have to be bad, and they can grasp your attention and create buzz. I think that this is the case here and it attracts people because there is something intriguing and familiar in the scent of burnt hair. Everyone knows what that smells like, and there is a familiarity aspect there, as well. I personally remember bending over a candle as a kid and smelling a hair that caught fire, and like that, I think we all have smelled it at some point. It's also not a repulsive scent, so all in all, I can see the intrigue.

***P&F+*: Working with major celebrities and figures is common for Firmenich, can you share some of the details behind what that collaboration entails?**

FV: At Firmenich, I've met and worked with quite a few celebrities, and they are actually quite often really into fragrances and creating something they feel great about. Even though they don't have the "traditional" perfumery training or experience, they do have a passion and a strong opinion on what they like and don't, which is great. I enjoy working with someone who is not in my field and finding a common ground to create something that really represents who they are and what they stand for.

***P&F+*: Does this scent say anything about the trends of the market?**

FV: There's a desire to stand out and be different today, even olfactively speaking. The consumer is also much more educated and well-versed in fragrances today and in turn may be more curious and are more comfortable going into different territories that have a strong point of difference. These consumers don't feel the need to stay in comfortable or traditional realms of scent, since they are willing to stand out.

An Insider's Take on Plant-based Formulation



According to Horridge, the most prevalent challenge (in plant-based formulation) is balancing taste, texture and visual aspects and packaging it all up in a cost-effective product that consumers love.

Plant-based formulation continues to make significant progress in both taste and in texture over the years. Thanks to new technology and innovation, this market has seen continued growth. But what is the market up to lately? What are the current consumer demands, and how are they shaping formulation?

Perfumer & Flavorist+ connected with Chris Horridge, RD&A director at Kerry in North America, to discuss the latest innovation in the plant-based sector.

***P&F*+: Can you touch on some of the latest consumer trends regarding plant-based products? How is that influencing formulation?**

Chris Horridge [CH]: Consumers are more focused on making better food choices, aiming for products that benefit their overall health and that are sustainable for the planet. Increased consumer demand has helped propel plant-based industry innovations into new categories that may have seen slower adoption. "Health" and "nutrition" continue to outrank other purchase drivers for plant-based food, and we see that today's consumer has adopted a more holistic approach to personal health. Their acceptance of various food trends and an active physical lifestyle has ultimately led to more mindful food and beverage choices. In the search for a simplified and convenient solution for a "better-for-you" lifestyle, more consumers are incorporating plant-based food into their diets. Plant-based food provides easy and accessible solutions to eating healthy without demanding drastic dietary changes.

Consumers want the positive benefits of a vegetable-enriched diet without giving up the taste, texture and protein levels of traditional meat and dairy products. Creating plant-based products that address key health and nutrition goals will further entice consumers to the category. Regardless of the final application, formulating to meet the taste, texture, performance and nutritional expectations while maintaining a clean label is challenging for most companies innovating within the plant-based meat category. As consumers' expectations continue to evolve, strategies to continuously improve product attributes, deliver on taste, optimize nutrition, deliver simple and trusted labels, while providing a characteristic meat-eating experience, will be imperative to success in this rapidly growing category.

***P&F*+: What are some of the recently debuted technologies for plant-based formulations?**

CH: Plant-based is a fascinating place to be at the moment; there is a lot of exciting innovation

going on. A lot of this activity is being targeted at getting closer to whole muscle-type products. High moisture extrusion or technologies that have been around for years are still the go-to technologies today. What is interesting is we are seeing start-ups showcase a new twist on those processes, a different order of addition that has taken them a step closer to whole muscle products, but we still have a way to go. Meanwhile, from an ingredient perspective, the extraction of protein is increasingly coming from novel ingredients.

***P&F+*: What have been some of the most prevalent challenges for formulating plant-based and/or better-for-you products?**

CH: Taste trumps everything in plant-based products trying to mimic meat. Taste is inextricably linked to the value someone may hold in a product and therefore impacts cost, the other key driver. Taste is also built on texture which could be seen as the vehicle for delivering taste. Get the texture wrong and a product trying to mimic meat just doesn't deliver, no matter how good the taste. One other key consideration is the visual aspect—after all, we eat with our eyes. The most prevalent challenge is balancing taste, texture and visual aspects and packaging it all up in a cost-effective product that consumers love.

***P&F+*: From your perspective what does the future of plant-based look like?**

CH: As more consumers incorporate plant-based meat alternatives into their lifestyles, the opportunities are endless for the category. Although burger patties are the most widely available plant-based meat alternatives, consumer interest is high for expanded formats. Innovation at Kerry continues to evolve into new plant-based categories that are not currently widely available in stores or restaurants today. This creates new formulation challenges but also opportunities for new ingredient solutions to solve for new taste, texture, performance and nutrition issues with these new products. Ensuring the right mix of ingredients, technologies and techniques is key in formulating the next winning plant-based meat alternative and it is formulation and technical expertise that can steer the next plant-based solutions to the finish line.

p&f+

Fragrance Creators Announces Additions to Fragrance Conservatory

Fragrance Creators Association (Fragrance Creators) has announced the addition of nearly 150 ingredients to its Fragrance Conservatory (*fragranceconservatory.com*). The conservatory is said to include 448 fragrance ingredient profiles, designed to provide information on ingredients in scented home and fabric care, beauty and personal care products, and fine fragrances. Alongside dedicated pages on fragrance safety, well-being benefits, history and more, the website's Ingredient Directory features profiles on the scent, origins, safety, and more of individual fragrance ingredients.

Farah K. Ahmed, president and CEO, Fragrance Creators, stated, "*FragranceConservatory.com* operationalizes our members' commitment to empowering consumers with high-quality information about the fragrances contained in the products they use every day. We encourage all companies along the fragrance value chain to link to the site so, together, we can advance consumer knowledge and understanding about the safety and important well-being benefits fragrance delivers. We are proud of the continued growth of this essential resource to ensure that fragrance facts and insights remain accessible to everyone."

p&f+



Discover the newly added ingredients by visiting Fragrance Creators' Fragrance Conservatory.

IFRA U.K. Presents Sense of Smell Survey Results

The International Fragrance Association U.K. (IFRA U.K.) has undertaken a recent YouGov survey to take an in-depth look at the United Kingdom's sense of smell and how much it is valued.

The survey showed that less than 1% of U.K. adults will acknowledge having no sense of smell, with women more likely than men to say their sense of smell is excellent. It also revealed that over half of U.K. adults (55%) say they notice the smell of things five or more times a day and almost two-thirds (64%) say they can imagine particular smells well, such as cut grass, fresh laundry and fried onions. Nearly half the population (49%) notice the scents of friends or relatives, and over two-thirds (71%) of the population notice the smell of places they regularly visit, such as museums, holiday spots or churches.



The survey showed that less than 1% of U.K. adults will acknowledge having no sense of smell, with women more likely than men to say their sense of smell is excellent.

The survey revealed that for 60% of U.K. adults, the main feeling evoked by their sense of smell is nostalgia. Much of that sense of comfort and sentimentality is connected to food—almost a third of U.K. adults (32%) appreciate their sense of smell because it helps sharpen their appetite. When asked what childhood smells they remember, responses included "freshly mown grass," "cakes baking," "the smell of rain," "melting Tarmac," "Sunday roast cooking" and even "school dinners." When asked what smells they no longer encounter and miss, many responses were linked to food and home comforts, including "grandparents' cooking," "Grandma's kitchen," "my Mum's face cream" and "Grandad's shed."

The survey identified that the top reasons people value their sense of smell are:

- It helps them be alert to feelings of cleanliness and hygiene (50% of U.K. adults)
- It draws their attention to unpleasant things (49% of U.K. adults)
- It reminds them of people, places and things in the past (44% of U.K. adults)
- It sharpens their appetite (32% of U.K. adults)
- It makes people feel more aware of the natural world (31%)

Lisa Hipgrave, director of IFRA U.K., said, "The survey shows that people are much more aware of their sense of smell than is widely assumed and many can easily recall and identify important smells and scents. Unsurprisingly, with loss of smell listed as one of the main symptoms of COVID-19, many people value their sense of smell more than they did three years ago, pre-pandemic."

Barry C Smith, director of the Institute of Philosophy at the Centre for the Study of the Senses and chair of IFRA U.K.'s Fragrance Forum 2022, said, "We average around 20,000 breaths a day with each one informing us about our surroundings. As the survey revealed, we use our sense of smell to indicate if something is fresh, to sharpen our appetite, and to alert us to unpleasant things. The olfactory receptors in the nose connect us directly to areas of the brain that create memories. That's why our sense of smell is so important to our well-being and to feel connected. It connects us to our present surroundings but also to our pasts with familiar aromas evoking feelings of nostalgia. At this year's Fragrance Forum, we will delve deeper into what people think about their sense of smell, the role it plays in their lives and how we can measure how good it is or isn't."

Argeville Opens South African Development Center

Argeville has debuted its latest development center in Johannesburg, South Africa.

The center is said to be part of the company's plan to strengthen its international development and consolidate its presence in strategic commercial areas. The aim is also to get closer to its regional customers, with whom it has worked for over 20 years on a cross-category product offers, including fragrances, personal care and air care.

Jointly managed by Richard Kourennoy, Africa sales manager, and Ignacio Garcia, the center is designed to grow rapidly with the arrival of new collaborators.

Located in Rosebank, the business and commercial district of Johannesburg, Argeville strategically placed this location at the crossroads of the main transport routes to allow quick access to the city center.

Argeville has also announced that it is working on establishing new centers in 2023.



The opening is part of the company's plan to strengthen its international development and consolidate its presence in strategic commercial areas.

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PROFILES:
DARRYL DO and ALISON FREEDMAN

Get to know the F&F journeys of these two advisory board members.

Darryl Do, perfumer, Delbia Do Fragrances & Flavors

***Perfumer & Flavorist+*: What led you to the fragrance industry? Can you share your journey?**

Darryl Do: You could say I grew up in this industry training under my dad, Dennis Do. He was a perfumer and flavorist who started out working for other companies in the industry, Perry Brothers, UOP, Ungerer among others, before he started his own company, Delbia Do Fragrances & Flavors located in the South Bronx. This is one of the few areas of New York City zoned for manufacturing M1-M2, required for the flammables we used.

I would work in the lab, refilling bottles, light compounding, cleaning tanks and equipment used in perfumery manufacturing.

Since many of his friends were perfumers, chemists, and owners of other fragrance companies, he would ask them if they needed any help, volunteer my services and I would happily oblige. He told me that this was the best way to learn all the different areas of the business. Once I was out of college and finished my "formal" training, I was ready to begin my practical training. Dad had a friend, Vincent Ellis, who was leaving his position as chief perfumer at Felton and was starting his own fragrance house. (This is the first instance I can remember of a "indie perfumer"). I became his apprentice/compounder for two-three years, evaluating raw materials with him.

Then in 2001, after 9/11, my dad's friend Marguerite [Wytenhove] wanted to move out from her space in Tribeca and decided to come up to our building in the Bronx. This became the home of M. Wytenhove, the U.S. Distributor for Laboratorie Monique Remy and Synarome USA for 10+ years. I was spoiled working with these amazing oils.

I look back on the old ingredient landscape and find myself missing musk ambrette and musk xylol, BUT there are a few newbies! Amber Xtreme, Cashmaran and nootkatone to name a few. I continue to search for the latest and greatest out there to keep my creative juices flowing and this is the part I get excited about.



Name: Darryl Do

Title: Perfumer

Location: New York City, New York

I fill the need from fragrance and flavor development, toll compounding to custom formulation and blending of alcohol solutions perfumes and colognes for other fragrance houses, perfumers and beauty brands. As my dad would ask, "what do you need, I'm sure Darryl can help."

Alison Freedman, certified flavorist, Firmenich

***Perfumer & Flavorist+* [*P&F+*]: What led you to the flavor industry?**

Alison [AF]: Fate and following my efforts. I graduated with a degree in Food Science & Technology from Virginia Tech and ended up with

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the good fortune of finding an opportunity to work in the industry through networking. I never gave up on proving my ability early in my career, and I consistently expressed my sincere interest in training with flavorists by offering to help their team whenever I had a moment of downtime.

***P&F+*: What applications do you primarily formulate for? Do you have a favorite?**

AF: I work cross-functionally and I love being able to touch them all–variety is the spice of life. I sincerely enjoy each segment in its own way–savory for a challenge and complexity, beverage because I love a moment to imbibe, and sweet goods because, well, who doesn't love something sweet?

***P&F+*: Advice for people coming into the flavor field.**

AF: Go above and beyond, however you are able. Remain curious. Maintain a level of humility. Determination, passion and initiative can take you far.

***P&F+*: Are the types of projects you're working on changing over time? How are the creative demands of the job evolving?**

AF: The world is evolving at an incredibly fast pace and we are living in a digital age. Flavorists are engaging now more than ever with technologies and artificial intelligence-based tools to continuously improve our speed of execution. Global supply chain disruptions and inflated costs have brought out new ways for flavorists to creatively deliver sustainable, cost effective products.



Name: Alison Freedman

Title: Certified flavorist

Location: New York City, New York

***P&F+*: What is the best part of your job?**

AF: Being part of a team and experiencing the thrill of our success and the agony of our defeat together. No two days are ever the same in this industry and having the opportunity to learn each day is a blessing. The very best part is waking up each day and coming to work with true purpose: creating positive emotions to enhance well-being through my flavor creations.

p&f+

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Pomegranate flavors have surged in popularity in recent years and many of them incorporate a few fantasy components. Levels of 30 ppm of 6-methyl-5-hepten-2-one help enhance authenticity.



BY JOHN WRIGHT
johnwrightflavorist@gmail.com

Flavor Bites: 6-Methyl-5-hepten-2-one

This material widens the range of use to include flavors that heptan-2-one, for example, would struggle to adapt to.

6-Methyl-5-hepten-2-one (FEMA# 2707, CAS# 110-93-0) is an interesting, and rather unusual, raw material. It has a number of fairly close relatives. Heptan-2-one is distinctly blue cheese in character, vital in all dairy flavors. It is also somewhat interesting in many other categories but difficult to incorporate. Heptan-4-one is distinctly fruity and pineapple in character and quite different from heptan-2-one. It has a fairly limited area of use in the fruit flavor category.

6-Methyl-5-hepten-2-one sits somewhere in between these two very clear profiles. It has a soft and attractive fruity character, combined with a modest hint of blue cheese. This contrarian combination of nuances might, in theory, render a raw material difficult to use. In this case, it actually widens the range of use to include flavors that heptan-2-one, for example, would struggle to adapt to. Heptan-2-one only really retains a dominant position in dairy flavors.

Note that the dose rates given throughout this article are the levels suggested for use in flavors intended to be dosed at 0.05% in ready-to-drink beverages or in a simple bouillon.

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Vegetable Flavors

Cooked rice: Rice is at the opposite end of the complexity spectrum to ginger. Flavors are, all too often, very simple. Levels of 100 ppm of 6-methyl-5-hepten-2-one add detail and realism.

Ginger: Ginger is a frustratingly complex profile to work with. Outside of natural ginger oils and extracts, the list of ingredients that push the profile in a positive direction is sadly limited. 6-Methyl-5-hepten-2-one, at around 400 ppm, has a positive, refreshing, influence.

Spring onion: A similar effect can be seen in spring onion flavors. The ideal level of addition is somewhat lower, around 50 ppm.

Toasted corn: 6-Methyl-5-hepten-2-one adds complexity and authenticity to all types of corn flavors, but especially to toasted corn profiles. Levels of 20 ppm have a significant impact.

Tomato: Many ingredients have a natural home, a flavor where their impact is maximized. In the case of 6-methyl-5-hepten-2-one, it is tomato. This ingredient is important in all types of tomato flavors. Fresh and processed tomato flavors have an ideal level of addition around 1,000 ppm. Sun dried tomato flavors, understandably, need a little more, around 2,000 ppm.



Outside of natural ginger oils and extracts, the list of ingredients that push the profile in a positive direction is sadly limited. 6-Methyl-5-hepten-2-one, at around 400 ppm, has a positive, refreshing, influence.

Citrus Flavors

Grapefruit: 6-Methyl-5-hepten-2-one, at around 20 ppm, lifts grapefruit flavors and adds realism.

Lemon: The same 20 ppm level has a very similar effect in all styles of lemon flavors.

Mandarin: The effect is noticeably more pronounced in mandarin flavors and really serves to differentiate the profile.

Orange: A perfectly reasonable level of addition for orange flavors is 20 ppm, but a higher level, around 50 ppm, pushes the profile in an attractive tangerine direction.

Tangerine: Overtly tangerine flavors can make good use of even more 6-methyl-5-hepten-2-one, up to 200 ppm.

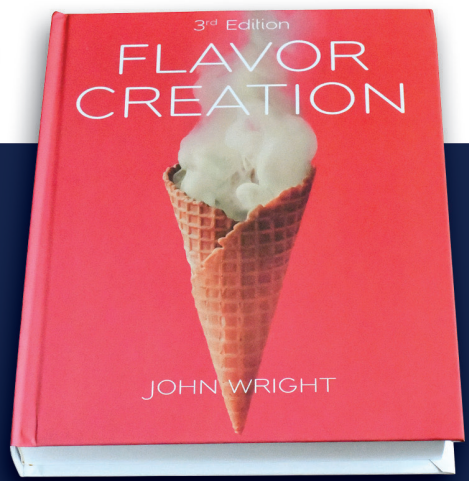
Orchard Fruit Flavors

Apple: Apple flavors excel at bright estery and green notes but can lack balance and complexity. 6-Methyl-5-hepten-2-one helps to round out the profile of apple flavors at around 100 ppm.

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Apricot: A similar level, 100 ppm, lifts all styles of apricot flavors, working equally well in fresh and dried styles.

Cherry: 6-Methyl-5-hepten-2-one counteracts benzaldehyde in cherry flavors and helps to lever the profile in a more authentic direction at 100 ppm.

Nectarine: Nectarine flavors benefit from more modest levels of 6-methyl-5-hepten-2-one than apricot flavors, very much in line with the more subtle profile of nectarines. A good starting point is 50 ppm.

Peach: The opposite is true for peach flavors. In this category, 150 ppm is ideal.

Pear: The profile of pear flavors bears some similarity to apple flavors and the ideal level of 6-methyl-5-hepten-2-one is the same, 100 ppm.

Other Fruit Flavors

Blackcurrant: 6-Methyl-5-hepten-2-one, at around 100 ppm, adds an interesting twist to realistic blackcurrant flavors.

Blueberry: Many traditional blueberry flavors have an element of floral fantasy in their profile. This ingredient can work in this category, but only at a modest level. In contrast, fresh flavors can make good use at levels ranging from 500 ppm to 800 ppm.

Gooseberry: Gooseberry flavors only surface occasionally, but the profile is very interesting, with methyl esters playing an important role. This raw material helps integrate these esters at around 100 ppm.

Kiwi: The complex character of 6-methyl-5-hepten-2-one helps add realism to delicate kiwi flavors at 20 ppm.

Mango: There is a level of affinity between the skin notes in mango flavors and 6-methyl-5-hepten-2-one. An ideal level of addition is 200 ppm.

Pomegranate: Pomegranate flavors have surged in popularity in recent years and many of them incorporate a few fantasy components. Levels of 30 ppm of 6-methyl-5-hepten-2-one help enhance authenticity.

Watermelon: 6-Methyl-5-hepten-2-one helps to integrate the fruity notes derived from aliphatic esters in watermelon flavors and forms an important part of the total profile. A good starting point is 500 ppm, working equally well in both realistic and fantasy style flavors.

Other Flavors

Burnt sugar: An effective level of addition in burnt sugar flavors is 10 ppm, just enhancing complexity a little. The same level is effective in caramel flavors.

Cocoa: This raw material only plays a minor role in cocoa flavors, simply adding realism at around 20 ppm. It is also effective in chocolate flavors at levels ranging from 10 ppm to 20 ppm.

Coconut: δ-Octalactone is the ideal character recognition component for authentic coconut flavors, blending particularly well with 6-methyl-5-hepten-2-one, added at around 20 ppm.

Rose: Most rose flavors fail to escape from the very pleasant confines of obvious rose otto notes. 6-Methyl-5-hepten-2-one, at around 10 ppm, adds fresh rose petal lift to the profile.

Seafood: Building detail into the heart of seafood flavors is quite a challenge. 6-Methyl-5-hepten-2-one is effective, at levels ranging from 80 ppm to 120 ppm, in all categories. It is arguably most effective in crab flavors.

Tea: Tea flavors are another flavor category where 6-methyl-5-hepten-2-one is effective right across the board. The ideal levels of addition vary a little. Levels of 100 ppm work well in black tea flavors and levels of 200 ppm and higher can work in green tea flavors, depending on the profile.



This raw material only plays a minor role in cocoa flavors, simply adding realism at around 20 ppm.

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Application of Gas-Liquid Chromatography to the Analysis of Essential Oils

Part 2: Fingerprint GLC of the final two of five ketone containing essential oils.

BY M.J. MILCHARD, N.C. DACOSTA, R. ESDALE, L. GATES, P. MACCORMICK, P. MERLE, G. MORAN, N.E. MOSS, D.A. MOYLER, N. OWEN, N. ROACH, A. SHERLOCK, T.D. SMITH, B. STARR, J. WEBB and R. WOOD



The results obtained show a fingerprint gas chromatogram and a corresponding table of the composition for each oil.

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Considerable literature data are available on the composition of essential oils. However, much of this relates to small scale experimental trials. For regulation purposes, such as REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) and now U.K. REACH, detailed information on the composition of commercially traded essential oils is required.

GLC (gas liquid chromatography) fingerprint chromatograms of five authentic essential oils were obtained in a collaborative study using the recommended procedure given in Part XVII of this series and are presented here (this paper represents Part XXV, cedarwood oils was Part XXIII, ester containing oils was Part XXIV).[1,2,3] The samples examined were oils of two different commercial chemotypes of cedarleaf, two different commercial chemotypes of bitter fennel and wormwood. These were selected in consultation with the U.K. essential oil trade through the BEOA (British Essential Oil Association). The results obtained show a fingerprint gas chromatogram and a corresponding table of the composition for each oil and will enable the correct regulatory assessments to be made. The expert working group gratefully acknowledges the staff time and samples of essential oils provided by the companies involved in this study.

ABOUT THIS 2-PART SERIES

Part 1: Experimental, results, thujones and cedarleaf oils (December 2022)

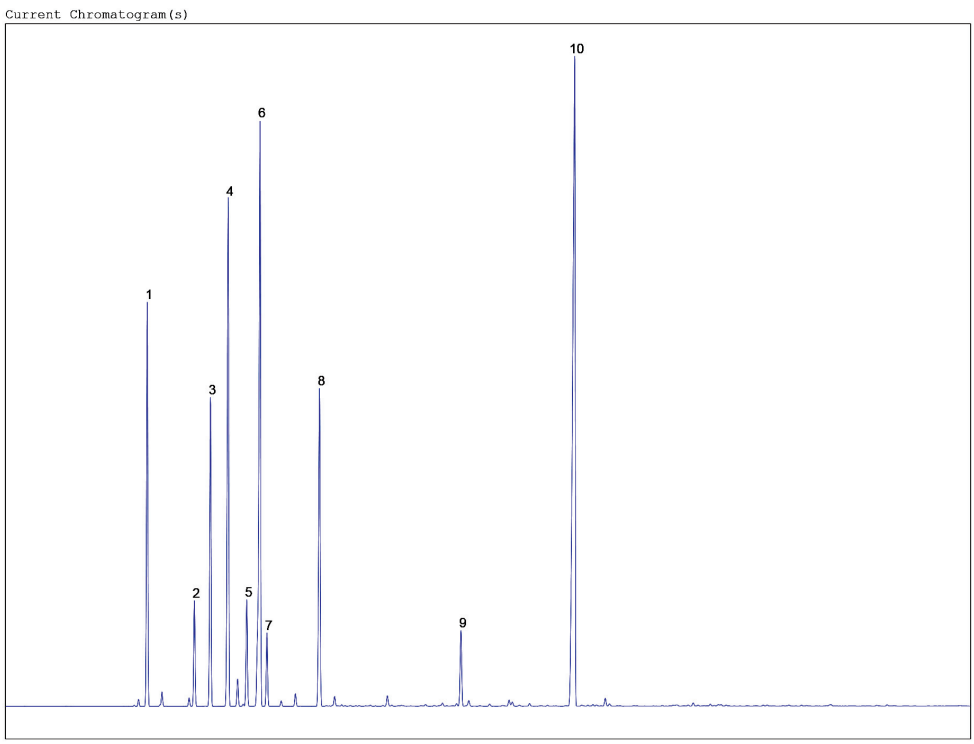
Part 2: Fennel oils and wormwood oil (January 2023)

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Fennel Oils

The oils that are steam distilled from the plant, a member of the *Apiaceae* family, are mostly processed in Mediterranean countries. They usually contain about 10% of fenchone, as well as variable amounts of anethole, dependant on the chemotype. None of the thujone isomers have been reported as occurring in the sweet fennel oils.

F-4 GLC of fennel oil bitter anethole type



Seed of the bitter variety *Foeniculum vulgare* Mill. has two chemotypes available commercially. The more abundant is the anethole type but there is also a phellandrene type, both being recognized with separate specifications within this oil's ISO standard 17412 (2007).

Oil of Fennel Sweet

These oils are steam distilled from the crushed seed of the cultivated plant, *Foeniculum vulgare* Mill. subspecies *vulgare* var. *dulce* (Mill.) Batt. It is also occasionally known as Roman fennel and is grown in several Mediterranean countries.

It is a pale yellow mobile oil with a warm, sweet, spicy odor and anisic taste and contains about 80% of trans-anethole, 10% of fenchone, 3% methyl chavicol (estragole), 1% anisaldehyde and 6% monoterpene hydrocarbons.

Sweet fennel oil is primarily a flavor ingredient, especially in anisette liqueurs, confectionery, oral care and pharmaceutical cough treatment products.

Due to the simplicity of this oil and its well documented composition, it has not been studied here.[7]

It has a FEMA registration number of 2483 and a COE monograph number 200.

Oil of Fennel Bitter, Anethole Type

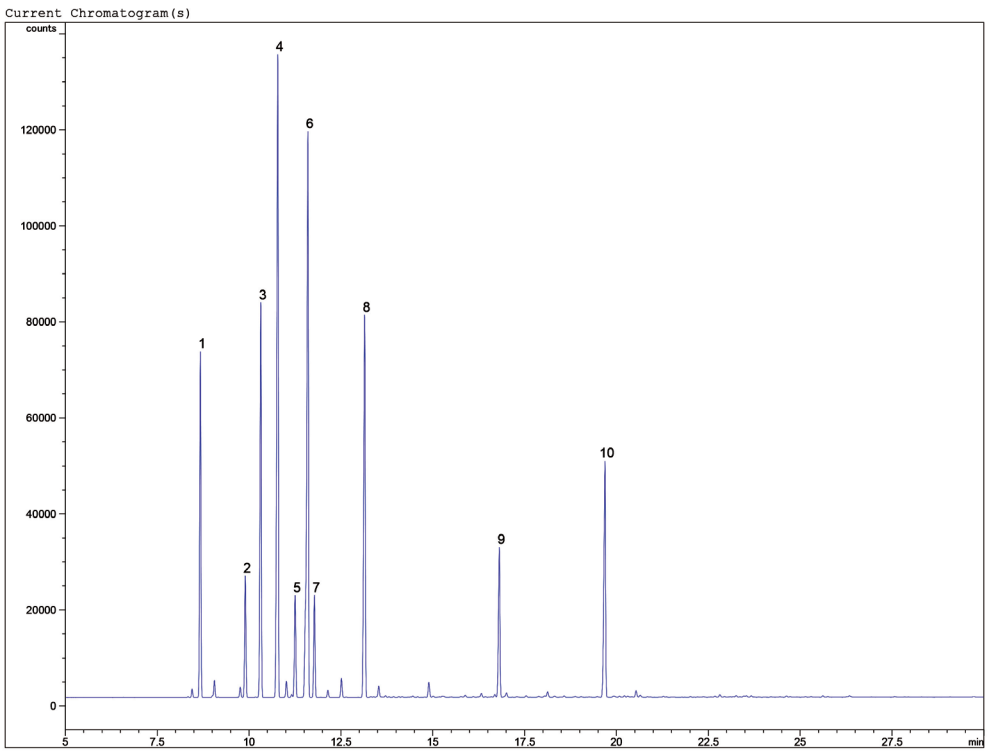
Steam distilled from the crushed seed of the cultivated plant *Foeniculum vulgare* Mill. subspecies *vulgare* var. *capillaceum*, which is identical to the plant variety growing wild. Although grown in many parts of the world, distillation usually takes place in Spain, France, Germany, Hungary, Italy and India.

It is a pale yellow mobile oil with a warm-camphoraceous, sweet, spicy odor and a distinctly bitter, earthy, anisic taste. These are the organoleptic characteristics which differentiate it from the sweet fennel variety. The total monoterpene hydrocarbon content of the anethole type is ~60% which is lower than the ~73% typically found in the phellandrene type of oil.

Bitter fennel oil is primarily a flavor ingredient, especially in liqueurs and at low levels as a modifier in fruit confectionery, but the bitter taste and camphoraceous notes limit its level of use. It does have some uses in oral care and medicinal products.

The Spanish oil tested here is a specific consignment of a typical volume traded oil, which represents the characteristics of the source. However, it can be seen from **T-3** that, although this is a commercially traded oil, not all of the component compositions fall

F-5 **GLC of fennel oil bitter, phellandrene type**



T-3. Composition of east Canadian cedarleaf oil

RRI	constituent	%	ISO 17412
924	α-thujene	0.1	
932	α-pinene [1]	9.5	2-11
946	camphene	0.4	
967	sabinene	0.2	
972	β-pinene [2]	2.6	trace-1
983	β-myrcene [3]	7.7	0.5-2
994	α-phellandrene [4]	13.7	trace-8.5
1002	δ-3-carene	0.7	
1009	p-cymene [5]	2.7	
1021	β-phellandrene	0.7	
1022	limonene [6]	17.7	1-6
1024	(Z)- β-ocimene [7]	1.8	
1038	(E)- β-ocimene	0.1	
1046	γ-terpinene	0.3	
1064	fenchone [8]	9.0	10-25
1075	terpinolene	0.2	
1115	camphor	0.3	
1171	methyl chavicol [9]	2.1	1-6
1177	dihydrocarveol	0.2	
1207	anisaldehyde	0.2	trace-1
1229	(Z)-anethole	trace	0-0.5
1260	(E)-anethole [10]	29.0	50-78
1284	anise ketone	0.2	none-1
1936	STOH	0.1	
total:		**99.5**	

T-4. Composition of fennel oil bitter, phellandrene type

RRI	constituent	%	ISO 17412
924	α-thujene	0.2	
932	α-pinene [1]	9.1	2-8
946	camphene	0.5	
967	sabinene	0.3	
972	β-pinene [2]	3.4	1-4
983	β-myrcene [3]	11.2	1-12
994	α-phellandrene [4]	20.4	8-25
1002	δ-3-carene	0.4	
1009	p-cymene [5]	3.0	
1021	β-phellandrene	0.7	
1024	limonene [6]	19.8	8-30
1027	(Z)- β-ocimene [7]	2.8	
1035	(E)- β-ocimene	0.2	
1046	γ-terpinene	0.5	
1064	fenchone [8]	12.6	7-16
1075	terpinolene	0.3	
1115	camphor	0.4	
1157	terpinen-4-ol	0.1	
1171	methyl chavicol [9]	4.7	2-7
1177	MT	0.1	
1207	anisaldehyde	0.2	trace-0.3
1229	(Z)-anethole	trace	trace-0.5
1260	(E)-anethole [10]	8.3	15-30
1284	anise ketone	0.2	trace-0.05
1936	STOH	0.2	
total:		**99.6**	

within the ISO specification. This could be due to a variety of factors.

ISO standard 17412:2007 applies.

Oil of Fennel Bitter, Phellandrene Type

This oil is also steam distilled from the crushed seed of the cultivated plant *Foeniculum vulgare* Mill. subspecies *vulgare* var. *vulgare*. The odor is fresher, slightly more terpenic and herbal than the anethole type, but still clearly recognizable as bitter fennel. It is used mostly in vermouth and similar beverages where the fresher and less sweet notes are preferred and appreciated compared to the other fennel oils.

The Spanish oil tested here is a specific consignment of a typically traded oil, which represents the characteristics of the source. Apart from the slightly low (E)—anethole, this oil conforms to the ISO specification.

ISO standard 17412:2007 applies.

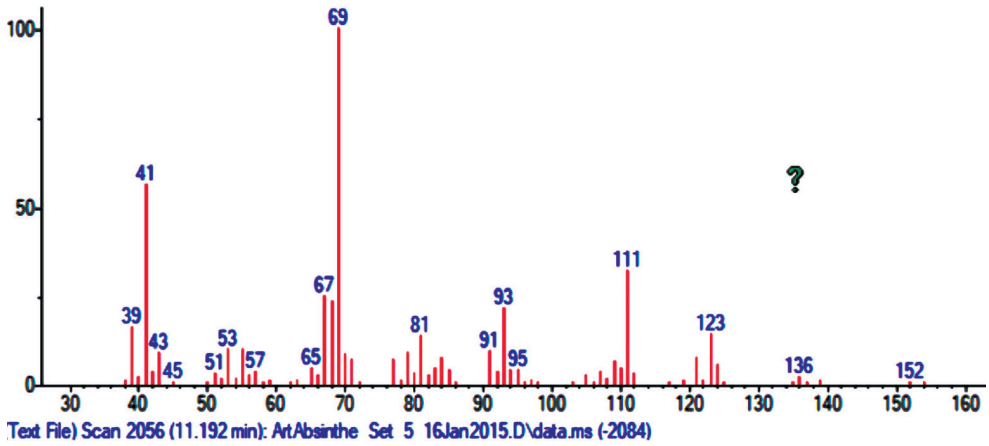
Oil of Wormwood

Artemesia absinthum L. is a herb of the *Asteraceae* family which is native to Southern Europe and cultivated in many countries including the mid-west United States, where it is also known as mugwort and is locally distilled. The steam distilled oil is from the β-thujone chemotype (of the five different types described in the COE monograph) of dried herb. The oil is a mobile, brown-green colored liquid.[8] It has a strong, substantive, herbal odor that is pleasant green-herbal hop or chamomile like in character. It has an intensely bitter taste.

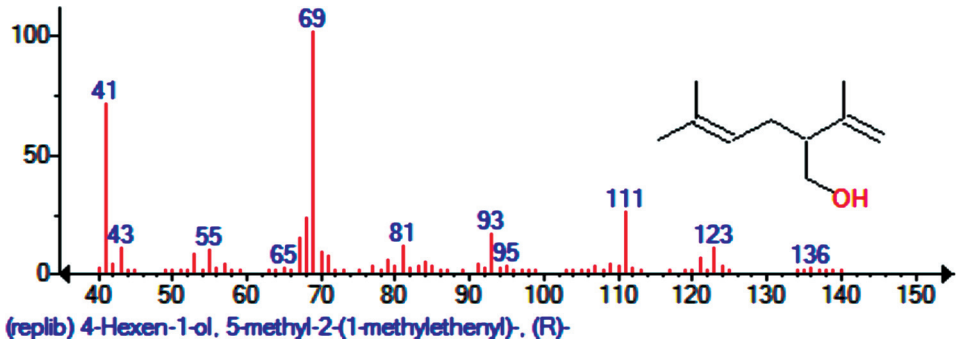
This oil contains about 50% of the α and β thujone isomers in the ratio 1:20, but no fenchone and its composition is reviewed in literature reported studies.[12] It finds widespread traditional use in vermouths, absinth and other bitter based alcoholic beverages.

There have been some discussions on the identity of the GLC peak eluting at RRI 1151 on

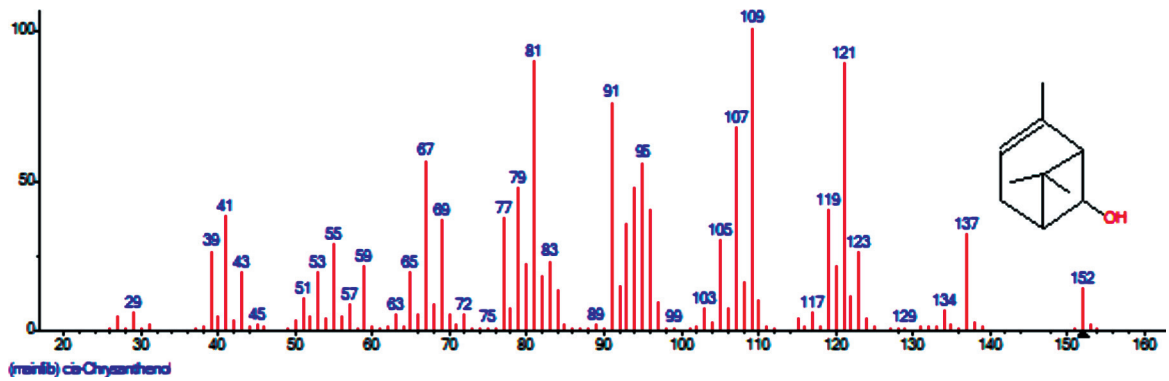
F-6 **Mass spectrum of peak at RRI 1151**



F-7 **Mass spectrum of lavandulol**



F-8 **Mass spectrum of Z-chrysanthenol**



T-5. Composition of wormwood oil

RRI	Constituent	%
831	(E)-2-hexenal	0.1
847	(Z)-3-hexenol	0.2
850	(Z)-salvene	0.3
852	(E)-2-hexenol	0.2
857	hexanol	0.4
932	α-pinene [1]	1.1
944	α-fenchene	0.2
946	camphene	trace
967	sabinene [2]	2.2
972	β-pinene	0.3
983	β-myrcene [3]	1.4
998	α-phellandrene	0.3
1012	p-cymene	0.2
1022	β-phellandrene	0.2
1023	1,8-cineole	0.3
1025	limonene	0.9
1035	(E)-β-ocimene	0.2
1049	γ-terpinene	0.1
1053	(E)-sabinene hydrate	0.2
1088	α-thujone [4]*	2.8
1088	linalol [4]*	2.0
1100	β-thujone [5]	43.3
1109	(Z)-β-ocimene-2,3-epoxide [6]	2.4
1117	thujyl alcohol	0.4
1122	(E)-sabinol	0.9
1125	(E)-β-ocimene-2,3-epoxide	0.3
1145	borneol	0.2
1151	lavandulol	0.8
1161	terpinen-4-ol	0.2
1171	α-terpineol	0.2
1211	nerol	0.2
1237	geraniol	0.1
1270	bornyl acetate	0.1
1277	(E)-sabinyl acetate [7]	23.3
1341	neryl acetate	0.2
1366	geranyl acetate	0.2
1383	β-elemene+β-bourbonene	0.1
1404	lavandulyl isobutyrate	0.2
1412	β-caryophyllene [8]	1.4
1429	neryl propionate	0.2
1445	α-humulene	0.2
1471	neryl isobutyrate	0.9
1473	germacrene D [9]	2.2
1478	β-selinene [10]	1.0
1487	bicyclogermacrene	0.4
1493	geranyl isobutyrate [11]	1.1
1496	lavandulyl isovalerate [12]	1.0
1512	δ-cadinene	0.1
1557	neryl 2-methylbutyrate [13]	1.2
1562	neryl isovalerate	0.6
1584	geranyl isovalerate	0.2
1588	geranyl 2-methylbutyrate	0.3
1606	MTES	0.1
1614	MTES	0.1
1630	geranyl valerate	0.2
1698	chamazulene	0.2
1995	STOH	0.3
2358	DT	0.4
2385	DT	0.2
total:		**99.0**

*Separated on a wax column

a non-polar column, as being either lavandulol or Z-chrysanthenol, as they have very close RRI when determined using flame ionization detection.

Using RRI on three columns (ZB-1, ZB-5 and ZB-Wax) and comparison with the NIST mass spectra shown above, this peak, **F-6**, is confirmed as lavandulol.

The U.S. origin oil tested here is a specific consignment of a typically traded oil which represents the characteristics of the source.

It has a FEMA registration number of 3116 and a COE monograph number 61.

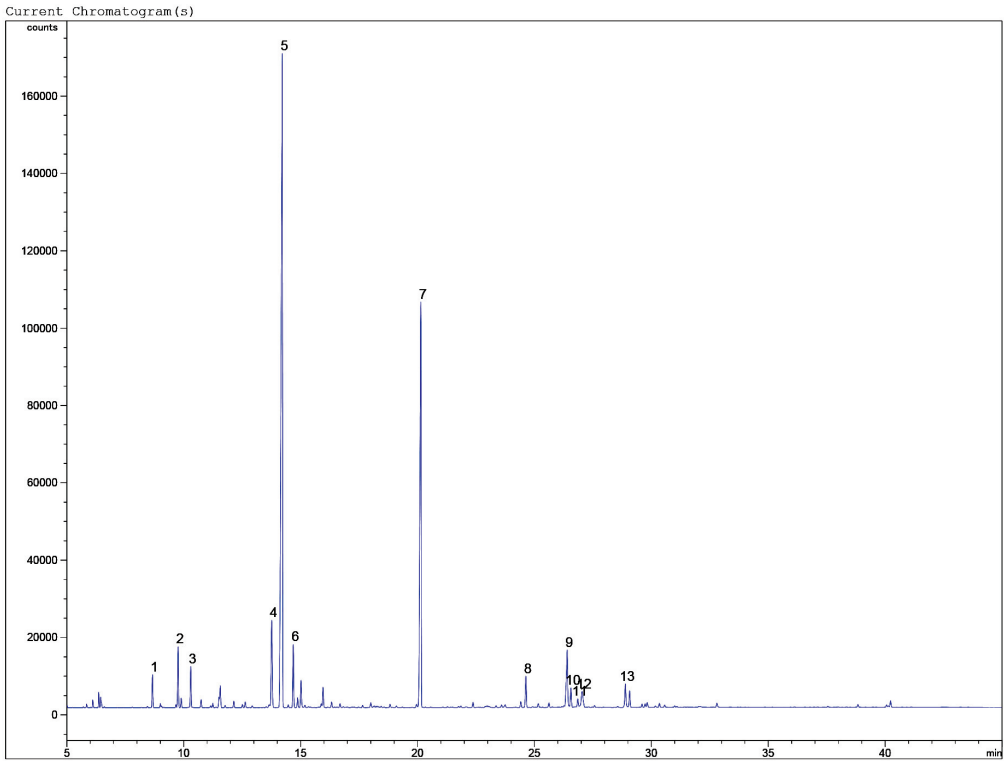
Address for correspondence:

The Secretary, Analytical Methods Committee, Analytical Division, The Royal Society of Chemistry, Piccadilly, London W1J 0BA, United Kingdom

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F-9 GLC of wormwood oil



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THE FUTURE OF **AI x FRAGRANCE**

The *World Perfumery Congress* provided a preview of a sensory future combining human expertise and computing precision.

BY OLIVIA JEZLER, founder, Future of Smell



Olivia Jezler



The Kaorium system enables a poetic interactive experience that invites consumers to smell, reflect and experience, building a new relationship to fragrances in a retail setting.

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Computational power and large amounts of data have led to breakthroughs in areas such as drug discovery, autonomous driving, machine generated faces and voices, as well as the customization of your favorite social media feeds. But when it comes to computationally created fragrances, can we smell them yet?

In June 2016, I asked the president of innovation at a large fragrance and flavor supplier whether they believe that robots will soon be able to create perfumes. They said they hoped to no longer be around if it ever were to occur.

In July 2022 at the *World Perfumery Congress* (*WPC*) in Miami, Symrise senior perfumer Dave Apel told me of the moment he knew the company's digital perfumery assistant, Phylria, worked, "I could relate to what the machine was doing. I watched it do something I studied 40 years for."

Futurist Roy Amara once said, "We tend to overestimate the effect of a technology in the short run and underestimate the effect in the long run." My two conversations, six years apart, and Amara's quip suggests that we have underestimated the potential of what lies ahead in the world of fragrance. Specifically, groundbreaking innovations are in the making when it comes to machine learning (ML)—a subfield of AI—that gives computers the ability to learn without explicitly being programmed.

This is not only great news to our noses, but also to many pharma CFOs because applications for the chemical industry are already leading to a tremendous reduction in time and R&D costs. For designers of flavor and fragrance, increases in creativity, sustainability and scent discovery are to be expected, with a vision to use ML for molecular synthesis as well.

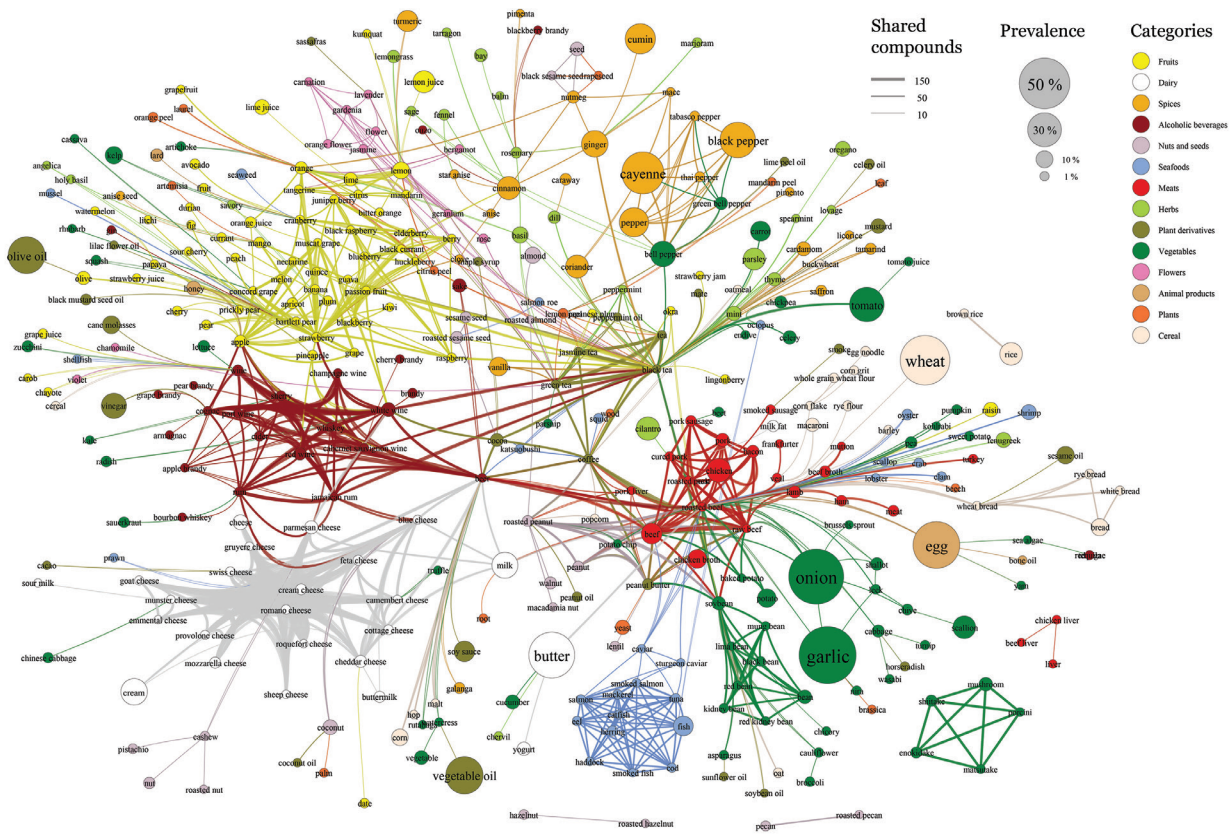
The Early Days of F&F and AI

More than a decade ago, an article[a] systematically identified the ingredient combinations responsible for the taste palette of regional cuisines from a molecular level (**F-1**). It was the most downloaded essay across all Springer Nature journals, exceeding

[a] www.nature.com/articles/srep00196

F-1 **Flavor Network**

Yong-Yeol Ahn, Sebastian Ahnert, James P. Bagrow, and A.-L. Barabási
"Flavor network and the principles of food pairing", *Scientific Reports* **1**, 196 (2011)



Flavor network. Culinary ingredients (circles) and their chemical relationship are illustrated. The color of each ingredient represents the food category that the ingredient belongs to, and the size of an ingredient is proportional to the usage frequency (collected from online recipe databases: epicurious.com, allrecipes.com, menupan.com). Two culinary ingredients are connected if they share many flavor compounds. We extracted the list of flavor compounds in each ingredient from the book "Fenaroli's handbook of flavor ingredients (5th ed.)" and then applied a backbone extraction method by Serrano et al. (*PNAS* **106**, 6483) to pick statistically significant links between ingredients. The thickness of an edge represents the number of shared flavor compounds. To reduce clutter, edges are bundled based on the algorithm by Danny Holten (http://www.win.tue.nl/~dholten/).

© Yong-Yeol Ahn, Sebastian E Ahnert, James P. Bagrow, Albert-László Barabási

100,000 PDF and page views in the first four weeks of its publication. The paper also buzzed across academia; I witnessed it cited at presentations from Oxford University to MIT.

A few years later, Chef Watson, powered by IBM's Watson, an AI supercomputer, was born. It understood food at the molecular level; learned about culinary traditions, people's likes and dislikes; and could compute unique flavors that would elicit surprise and enjoyment in consumers. Thereafter, however, progress was largely silent for almost a decade.

Meanwhile, in the fragrance realm, the first AI-developed fragrance hit the market in 2019, courtesy of Symrise and IBM[b]. At the same time, companies investing large sums into research and manufacturing facilities catering to AI have made headlines. Which makes me wonder—what is brewing behind the scenes, waiting to make the next big impact in fragrance and AI?

The *WPC* 2022 showcased three technologies that highlighted how the business of scent is being digitized from the supplier through to the consumer. What was once the province of intuition, taste, acquired skill and institutional knowledge is now being enhanced by emerging technologies.

Augmenting the Perfumer

Creativity is hard to achieve, yet easy to recognize. A successful fragrance fulfills human desire and adds an element of surprise. This element of surprise is where creativity comes in. Therefore, if a machine can identify and create something that has never been done before, then it can be argued that computational creativity exists[c].

One example is Philyra, a program jointly designed by IBM and Symrise to augment a perfumer's expertise and achieve higher creativity and sustainability in the creative process. The platform uses machine learning to help identify patterns and generate novel combinations of fragrance formulations. The program is led by Richard Goodwin, Ph.D., principal researcher of the Computational Creativity Research Group at IBM T.J. Watson. At Symrise, an internal cross-disciplinary group runs the effort, including VP senior perfumer Dave Apel.

The platform's data is encrypted, consisting of 20-plus dimensions of more than 2,000 raw materials and 3.5 million fragrance formulas. The algorithm learns from existing formulas, raw materials, historical success data and industry trends. Use cases include creating a new signature fragrance or flanker strategy based on white space analysis, as well as focusing on a micro-target or sustainability.

> "The future of smell will involve the synthesis of expert knowledge, data-driven scent development and an increase in consumers' sensory awareness, even when the scent of this composition is yet to reach our perceptual threshold."

The starting point for this tool is the fragrance formula, known as the "seed formula." Once the formula is added to the system, the perfumer can mark how far away from the original they are looking to push the boundaries in their creation.

To illustrate, Apel draws a set of concentric circles on a piece of paper and marks dots in the circles. Each dot represents a fragrance. The further away from the center, the further away we move from the success criteria. He then draws another set of concentric circles that overlap with the prior set. Apel proceeds by adding dots to the areas where the circles overlap. These, he says, are all unique possibilities of fragrances. Do we want the new fragrance to resemble what has been deemed successful in the past or are we willing to accept larger deviations and potentially be rewarded with entirely new creations?

Phylria can suggest alternative materials, considering dosing for each ingredient based on usage patterns, pleasantness and novelty of the fragrance by comparing it to a large set of commercially available fragrances. The technology also takes into consideration the technical qualities of raw material, including the molecular bloom, weight, vapor pressure and threshold of human perception.

The clean interface presents 12 new fragrance formulas per input. For a creative exploration, a perfumer can analyze the output formulas and choose a selection of them to be compounded in order to

[b] *www.soci.org/blog/2019/2019-01-22-first-perfumes-designed-by-ai*

[c] Google's Alpha Go, a program for the board game Go, beat the world master and led him to admit that he has never before seen the playstyle chosen by his artificial opponent; *https://www.bbc.com/news/technology-40042581*



Symrise VP senior perfumer Dave Apel is part of an internal cross-disciplinary group that runs the Philyra program.

smell them. The operating perfumer can also direct the Phylria platform to generate new combinations of fragrance formulations that fit specific design objectives—for example, creating a unique fragrance for Brazilian millennials.

Niche vs Mass Applications of AI Perfumery

O Boticario, a top global beauty and fragrance company, launched the first AI fragrance in collaboration with Symrise in 2019. At the time, the database contained more than 2 million fragrance formulas. Phylria tapped a warm milk ingredient that was available to perfumers from the flavorist palette and added fenugreek for the coumarin sweetness always found in a fougere accord in a way that has never been used before in this context. It was a moment of surprise for Apel; he did not know the flavor ingredient existed and never would have thought of adding it to create this olfactory effect.

Phylria thus proved that machinal creativity in the world of fragrance is possible. With minimal intervention of the perfumer, this fragrance composition was tested against a demographically pleasing benchmark, succeeded, and was brought to market. Alas, the sales figures of this fragrance did not meet expectations. When speaking to Symrise about this case, Apel emphasized that AI-assisted fragrances are in their infancy and fragrances created for broad commercial appeal probably do not meet the criteria of generating great surprise with novel notes.

On the other hand, the application of this technology to niche fragrance creations that generate tremendous love/hate reactions may be more appropriate. Having said that, Philyra offers insight into accords and combinations that play upon our emotions in a very targeted way. This type of development is the cutting edge of commercial development.

AI-driven Regulatory & Sustainability Compliance

In addition to pushing the creative boundaries, Phylria algorithm also suggests ingredient substitutes for formulas to comply with new safety and regulatory standards. It can, for instance, substitute

in more sustainable materials with higher biodegradability and renewability scores, all while keeping a similar olfactory profile. This offers unparalleled opportunity to design fragrances to be more environmentally conscious, potentially offering significant cost savings and increasing consumer demand.

An Olfactory Compass

While Philyra's starting point is a fragrance formula composed of fragrance ingredients and their respective weights, the Aryballe odor analytics platform's starting point is the fragrance itself.

During a demo at *WPC*, a tube attached to Aryballe's technology was placed inside a bottle to assess the headspace, i.e., the air above the fragrance. Within a second, the names of the molecules present appeared on an attached display. Just as quickly, upon removal of the odor, the graph showing the molecular reading reduced to zero, demonstrating the swiftness of the computational analysis and the sensitivity of the measuring device.

Aryballe is building a digital library of odors. The company has raised $18 million in total, including $7 million in its series B in 2020, with investors including Hyundai, Samsung, Asahi and IFF. Its suite of clients comprises several large fragrance houses.

Sam Guilaume, the co-founder and CEO of Aryballe, shared, "We don't know yet how many dimensions the odor space will have."

With one sniff, the company's sensor technology can identify an odor or fragrance not just based on single compounds but based on the way our nose detects scents through our receptors. It then situates this odor or odor composition on a digital odor map in relation to other fragrances or odors. One can zoom in to see similar odors and zoom out to view clusters of different odor groups.

Guilaume further explained the nuances of the technology, "Imagine you are using your GPS, it knows where you are on a continent, in a city and will help you navigate the space. Here, there are different continents, the vanilla continent, and the fruity continent for example."

The technology can be a compass. As a perfumer's tool, it can eliminate the step of a perfumer inputting a formula. It also allows them to work with more formula candidates and visualize the odor profile before executing a new fragrance, thereby greatly reducing time and cost associated with fragrance creation.



Aryballe's odor analytics platform is designed to assess the headspace of a fragrance.



Aryballe's technologies are designed to smell and identify an odor through a combination of biochemical sensors and advanced optics coupled with machine learning. The company's latest device, The NeOse Advance, introduced in 2021, is the first product based on Aryballe's silicon photonics-based platform.

The company's proprietary peptides, once grafted onto silicon, are able to respond to a wide variety of odors. Designed with heightened stability, Aryballe's peptides are said to be appropriate for a wide range of operating conditions and mimic the sensitivity of the human sense of smell. If your nose can smell it, so can the sensor.

The same sensor can be used to distinguish lavenders as well as to detect malodors in cars. Databases of odors can be created to fulfill specific client and industry needs.

Aryballe's odor sensor can be utilized to identify counterfeit fragrances, for example. It does this by not only analyzing the odor composition but by capturing each step of the perfume's evolution from top, mid to base note, based on volatility. This enhances the capability to distinguish between an original and a counterfeit because the counterfeit will diffuse differently, which can be captured better over time.

For automotive applications, Aryballe can help capture the odor data of materials to aid in vehicle part standardization and assist auto manufacturers in meeting their sustainability goals by monitoring recycled materials, which are known to emit smells that are undesirable to consumers.

In consumer appliances, the technology can enhance cooking appliances by adding automation features based on odor analysis to, for example, know when cookies have finished baking or when food in a refrigerator has gone bad.

Translating Scent into Words

Even the most novel, sustainable and beautiful fragrances will accumulate dust on product shelves if they are not embraced by customers. With almost 5,000 new fragrances launched between 2020 and 2021, it has become increasingly difficult for consumers to find fragrances they will love. In addition,

fragrances are able to elicit highly emotional responses, yet are difficult to put into words.

In a retail setting there still has not been much innovation beyond transferring an online quiz onto an in-store touch display or creating a blind smelling experience in which consumers can smell fragrances without knowing which brand or fragrance they are currently smelling—thereby eliminating visual and brand biases. This is where Kaorium by Scentmatic from Tokyo, Japan, enters the stage.

Kaorium is a digital table system with perfume bottles displayed in a semi-circle on top. The system enables a poetic interactive experience that invites consumers to smell, reflect and experience, building a new relationship to fragrances in a retail setting.

Attendees at *WPC* who interacted with the display gave it a 9.4 (out of 10) satisfaction rate and a net promoter score of 75. The technology is currently part of Shiseido Open Innovation Program and R&D center and is being used to develop new fragrances based on consumer data.

Scentmatic collaborated with Nose Shop in Shinjuku & Ginza, Tokyo. The Kaorium display took the center stage and increased store entry rate by 139% and sales conversion rate by 287%. Scentmatic CEO Toshiharu Kurisu's mission is to help people appreciate scent more and help them more easily discover the scent they like.

When asked whether there had been additional advertising, Shin Watanabe, director at Scentmatic, says that the company only marketed their display on social media. The post was picked up by an influencer account on Twitter, which generated additional buzz.

Watanabe added, "People are not ready to choose in [the] current buying experience. We are here to help solve this problem."

What is the Kaorium experience? Here's a breakdown:

- Step 1: The consumer selects their preferred fragrance from a selection of unmarked bottles and places it on a digitally connected coaster.
- Step 2: Various words that express the fragrance (such as "romantic" and "warm") float onto the table display. The consumer selects the word that to them best represents the fragrance that they just picked.
- Step 3: The display then illuminates a selection of fragrances and asks the consumer to smell these and choose the one that best matches the previously selected word.
- By repeating this process of consciously smelling fragrances, reflecting and connecting them to words, the system derives a pattern of the consumers individual perception and builds a database of word-scent associations.

The final output is an AI-generated poetic phrase that brings to life a sensory scene based on three fragrances and words selected in the discovery process. The names of the fragrances are only then revealed.

This AI-enabled consumer experience bridges the sensorial and rational mind and when asked what sets Kaorium apart from other AI technologies, Kurisu explained, "It invites consumers to smell,

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removing memories and biases, and allows them to take a moment to learn about their fragrance preferences." Such a process that requires presence and focus enables consumers to form a new relationship to fragrances.

As well as allows people learn an olfactory language, build the confidence to express their preferences and help them find their next scent.

Kurisu continued, "Scentmatic's goal is to create a dictionary for perfumes that translate words to scents and scents to words."

The tech combines gathered data from the consumer experience, coupled with professional, marketing data and Japanese novels. By using Kaorium's latest version, which can fit on a makeup counter, retailers can increase in-store engagement, education and improve sales while gaining new insight about consumers' preferences.

Learning how to smell fragrances without visual influences and how to express preferences in a world where at least 14 new fragrances are launched every single day holds more potential than we can currently foresee.

The World Ahead

Great progress has been made in bringing computational power, data and scent design together. The fact that machines can support perfumers and consumers alike is hardly a surprise on its own. However, the extent to which these novel approaches can expand the range of applications is striking, as all aspects—including computer aided purchase decisions, safety, cost and timing in R&D, digital signatures, certifications, sustainability, and creativity—are affected. The future of smell will involve the synthesis of expert knowledge, data-driven scent development and an increase in consumers' sensory awareness, even when the scent of this composition is yet to reach our perceptual threshold.

When I ask Apel, "What is the future of AI assisted fragrance design?" He simply replies, "Everything."

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The Intensifying Relationship Between Scent and Well-being

The latest innovations and portfolio launches in the functional fragrance market.

BY JENNA RIMENSNYDER, managing editor, *Perfumer & Flavorist+*

Companies featured:

- Givaudan
- Firmenich
- Majenye
- Scent & Fire



From mood boosting to better sleep these are the latest wellness-focused scent technologies and launches taking over headlines.

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The global health & wellness products market[a] is expected to reach a valuation of $6,900 million in 2022 with a robust CAGR of 6.9% between 2022 and 2032, totaling around $13,459.6 million by the end of 2032. With the growing consumer demand in the wellness segment, the fragrance industry has been booming with innovation both behind the scenes and on the shelves. Here are some of the latest companies making headlines.

Latest Platform Launches

F&F companies have been investing in research hiveminds to create portfolios that center around various aspects of wellness consumers are searching for.

One of which was Givaudan's Silver Radiance[b] program in September 2022, exclusively focusing on the silver generation (consumers over 55 years old). The company is said to have built the program based on consumer research with data collected from more than 7,000 seniors in 11 countries around the world.

The Silver Radiance Program is designed to help improve the quality of living while aging, through emotional, behavioral and physical benefits. The first step of this program was introduced through the Silver Radiance solutions, said to bring concrete tailored innovations to this population, from better sleep to higher energy levels.

Givaudan's portfolio of complementing technologies and active ingredients aimed to improve seniors' wellbeing include:

DreamScentz[c]: Technology explores fragrance solutions to enhance mood and the sleep experience. Givaudan developed the technology in alongside specialists in neuroscience, psychology, sensory science and fragrance at its Sensory Center of Excellence in Ashford.

MoodScentz[d]: Technology that aims to help consumers achieve a holistic sense of well-being through fragrance across all categories of perfume including

[a] *www.futuremarketinsights.com/reports/health-and-wellness-products-market*
[b] Silver Radiance Program is a registered trademark of Givaudan
[c] DreamScentz is a registered trademark of Givaudan
[d] MoodScentz is a registered trademark of Givaudan



Using Firmenich's ScentMove tool, which according to the company "provides a template for verbalization of emotions and enables the evaluation of feelings elicited by odors and fragrances," consumer insights professionals were able to connect the dots between specific emotions and focus.



Founder, Monisha Edwards, is on a mission to tackle mental health issues with products designed to de-stress environments.

fine fragrance, personal, home and fabric care as well as oral care flavors.

VivaScentz[e]: A fragrance technologies platform designed to guide perfumers and creative teams in crafting mood enhancing fragrances to evoke positive emotions.

Not long after in November 2022, Firmenich debuted EmotiCode Focus[f], an artificial intelligence-generated (AI), cross-category set of "design rules" for creating fragrances that enhance consumers' mental performance in cognitive tasks.

The rules represent the next evolution of Firmenich's EmotiOn program, which is designed to optimize the emotional impact of fragrances.

Using Firmenich's ScentMove tool, which according to the company "provides a template for verbalization of emotions and enables the evaluation of feelings elicited by odors and fragrances," consumer insights professionals were able to connect the dots between specific emotions and focus.

The company used these insights to develop "a set of design rules to create fragrances that evoke the emotional response linked to focus," known as EmotiCode.

Ilaria Resta, president, global perfumery, Firmenich, stated, "There are many potential benefits that the Focus fragrance can bring in people's homes, in their personal and shared spaces, and in their lives. Focus is crucial to mental wellness. Now, for the first time ever, we can help consumers achieve focus, wherever they are, with fragrance. These fragrances can deliver related benefits, such as mental efficiency and clarity of mind, bringing the power of Positive Perfumery to consumers."

On the Shelves

On the consumer-facing end, Scent & Fire founder, "Scent Bae" Monisha Edwards, is on a mission to tackle mental health issues with products designed to de-stress environments. The Black female-owned company's line-up includes fragrance collections made from domestically sourced raw and recycled materials. Edwards utilizes tech to enhance

[e]VivaScentz is a registered trademark of Givaudan
[f]EmotiCode is a registered trademark of Firmenich

aromatic experiences through curated music playlists and online community building.

After being diagnosed with PTSD, seasonal affective disorder and severe anxiety, Edwards discovered aromatherapy and burned candles to calm her environment and keep anxiety attacks at bay. This led to candlemaking on her own, which helped with her stress and depression, curating her own scent blends in soy wax. The now six-figure company offers collections ranging from candles, wax melts, room sprays and diffusers.

Edwards shared, "Through scent and sound, my customers and users can count on an eco-luxury multi-sensory experience without sacrificing wellness, sustainability or aesthetics. I create my products to beautify environments and provoke the senses with clean fragrances. Scent & Fire provides clean fragrance alternatives and aromatherapy experiences for self-care and a sense of wellbeing. Making the conscious decision to rise above any past trauma and mental issues, and using the gifts and talents I possess to make clean fragrances was my sole goal."

Vegan skin care company, Majenye, expanded its offerings with a candle line devoted to wellness-inspired scents to help users go to sleep. One of which being Lucid Dreams, holding notes of bergamot, rose, citrus, lavender, sandalwood, cedarwood and amber. The collection is designed to "emit a calming essence and fragrance throw that adds a unique ambiance that is perfect for winding down."

> With the growing consumer demand in the wellness segment, the fragrance industry has been booming with innovation both behind the scenes and on the shelves.

On the Horizon

With the surge of consumer products and the investment in research throughout the fragrance industry, it looks as though innovation is far from peaking in the scent and well-being segment. We are waiting with bated breath to see what next technology development will take over the headlines.

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PERFUMER NOTES: OUD

Take a look at the nuances, versatility and usage of oud.

BY ANA GÓMEZ, perfumer, Iberchem



Ana Gómez

The perfumer primarily uses oud for the formulating sophisticated fine fragrance products because of its high price.

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For its latest "Perfumer Notes" column, Perfumer & Flavorist+ connected with Iberchem perfumer, Ana Gómez, to explore her journey of formulating with oud. Gómez shared her personal and professional insights on the mystery and beauty of oud, a raw material she deems as being "worthy of some of the most luxurious perfumes in the world." You can also listen to a podcast featuring Gómez's take on the Middle Eastern fragrance market by visiting www.perfumerflavorist.com/multimedia.

First Impression

Everyone's first experience with oud is rather startling for many reasons. Oud is a well-known raw material in the Middle East, and, until recently, quite unknown in Europe and America (this is now changing thanks to the growing popularity of niche perfumery). When I first smelled it, I was very struck by its strong, animalic scent, almost fecal, some would say. A truly unforgettable sensation.

Many people say that oud leaves you speechless the first time you smell it. It makes you question whether a perfume that smells "good" could really contain this raw substance. The answer is that it can, but we need to smell it with an open mind.

Acquiring Oud

Let's start by looking at what oud actually is. Oud is one of the most popular ingredients in Arab culture. Agarwood comes from the *Aquilaria* trees, native to Southeast Asia. This wood is odorless and pale, but, when infected by the *Phialophora parasitica* fungus, the tree produces a foul-smelling resin that impregnates the wood to protect itself, making it harder and darker.

After some years, this infection will start to produce the precious oud oil. About 20 years after infection, the trunk of the tree begins to secrete resin, and it will take at least 50 years for there to be a usable proportion of infected wood. This slow ageing process directly influences the quality of the oil that will later be obtained, as the more years that pass after the infection, the more resin the tree will produce, and, consequently, the more fragrant the wood will be.

In the forests where these trees are found, only 7% of them are naturally affected by fungi, so nowadays a number of artificial methods are used to infect the trees and cause the resin to appear.

In the course of the whole production process, the infected parts of the tree are cut off to be refined for distillation or to be used as chips and burned as incense (a long-established tradition in the Arab world). The rest are left, in the hope that the tree won't die and the resin-infected wood will continue to grow.

Distillation is carried out using steam. The cut wood is soaked in water for a few months. It is then placed in large boilers and heated. The condensed water and oil are collected in a condenser and then separated.

The difficulty and time involved in obtaining it explains its high price. It is the most expensive ingredient in the perfume industry, and its price can reach $30,000 per kilo.

Exploring Uses

I keep oud for the most sophisticated fine fragrance products because of its high price and also because it's a product protected by CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), so I only use it when it's really worth it. Most of the time, it's used for fragrances intended for the Middle East—mostly premium-quality fragrances, depending on the project. I must admit that I sometimes add a hint of oud to more "French-style" perfumes bound for Europe, as niche perfumery is booming here, and oud adds a luxurious, unique touch.

Other products I consider using a hint of oud in are Middle East home care products, such as candles, bakhoors or air fresheners (both the spray type as well as reed diffusers). In these products, a touch of oud helps me to enhance the oriental nuances and give them more intensity and improve their potency.

Click above to listen to this exclusive podcast.

Oud's Versatility

Oud is a versatile, yet daring element, intended for a specific target audience. There are many types of oud from different countries (India, Cambodia, Laos, Thailand, etc.), and each with a slightly different olfactory profile (some more acidic, others sweeter and others more animalic or even more woody). However, they all share two common characteristics—intensity and sensuality.

As a main ingredient, it can only be found in fine fragrances. It is used in small quantities as it's very potent. In fact, by adding just 1% to 2% of it, you can infuse your fragrance with the scent of oud and transform it into something oriental and animalic, with oud as the composition's main ingredient. It is rare to see oud in volumes greater than 3% to 5%, as it is an ingredient that prevails above all others, and, in excessive doses, it can override the rest of the ingredients. In smaller quantities, 0.1% to 0.5%, it also has a very noticeable effect, providing exceptional durability, and a touch of mystery and darkness. However, in these cases, it isn't the dominant ingredient and it allows the other components of the fragrance to stand out.



According to Gómez, by adding just 1% to 2% of oud, you can infuse your fragrance with the scent of oud and transform it into something oriental and animalic.

It is also useful as a supporting ingredient in bakhoor incenses (an incense typical of Arabic culture, based on wood shavings mixed with essences) and candles. A small amount of oud in these blends helps to improve the diffusivity of the smoke, as well as providing a unique, rounded and much more sophisticated scent. I should also add that, in Arabic culture, oud has spiritual and religious significance, and so it helps to complete the more ethereal aspect of the fragrances.

Uniquely Oud

Oud is so utterly unique that it isn't like anything I've worked with before. It's certainly true that a trained nose can discern the different nuances when smelling it. You can smell the woody, animalic, damp, sweet, resinous, leathery notes and you can even notice hints of cypriol or gurjum. Yet it's different from everything else. It's a raw, almost wild smell. Sometimes, when I smell it, I think of a herd of wild horses running through a barren landscape, with the wind rushing through their manes.

Oud Highlights

I would like to highlight a few qualities of oud that, to my mind, make it unique.

Firstly, its intensity, and how, with a very small amount, it can change the whole character of a fragrance.

Secondly, how long it lasts when you add it to fine fragrances. Just a touch of oud in the composition can significantly increase how long it lasts, making the fragrance last for weeks on perfume strips.

And thirdly, the sensual, luxurious, exclusive and mysterious character it adds to oriental perfumes. It's simply unrivalled. Several synthetic compositions mimic the scent of oud and can create a similar effect in the fragrances, but the acidic/animalic long-lasting qualities that real oud brings to the fragrances are unique.

In conclusion, for me, oud is highly recommended and the real cherry on top to successfully creating a good oriental fragrance, as long as it's used responsibly and with good traceability.

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November 8-9, 2023
Duke Energy Convention Center
Cincinnati, Ohio

CELEBRATING *FLAVORCON*'S RETURN TO **CINCINNATI**

Get a taste of the flavorful two-day event hosted last November.

BY JENNA RIMENSNYDER, managing editor, *Perfumer & Flavorist+*



The flavor industry gathered for the two-day event filled with conference sessions, networking opportunities and expo hall exploration.

The *Perfumer & Flavorist+* (*P&F+*) team is feeling very thankful to the flavor community for supporting the long-awaited return of *Flavorcon* 2022. It had been three years since the last in-person event and attendees, exhibitors and speakers were itching to reunite in Cincinnati, Ohio.

Flavorcon is a global, interactive conference designed for flavorists, product developers, R&D leaders, food scientists and consumer packaged goods professionals designed to support sensory innovations and better-for-you breakthroughs for the flavor, food and beverage markets.

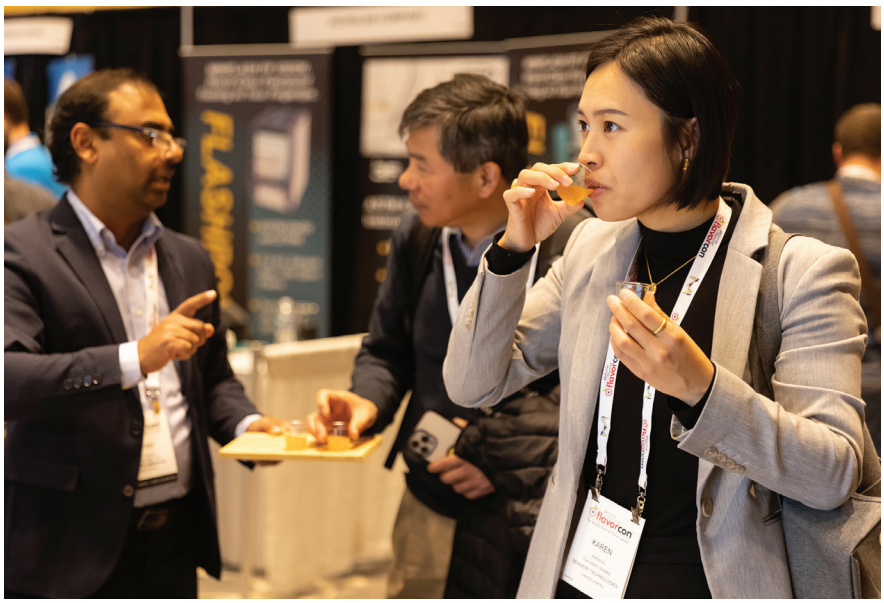
The two-day event was packed with samples from speakers, one of which was an 18-sample

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presentation hosted by ADM's Marie Wright alongside independent flavorist and "Flavor Bites" columnist, John Wright. Other sampling sessions included plant-based sips from Kerry's Rajesh Potineni as well as delicious scoops from Cincinnati's own Graeter's Ice Cream as well as flavor pairings. Thinking outside of the box, VCF Online's Willian van Dongen alongside Bell Flavors & Fragrances' and *P&F+* columnist, Cyndie Lipka, created interesting flavor pairings by using big data analysis, like scallops and Parmesan. Not to mention a beer tasting including sips from local and national breweries with the help of certified cicerone, Stephen Rich.

A special thanks to our inquisitive attendees who came to the event eager to learn from our speakers and were hungry enough to make their way to the microphones to keep the conversation going.

Exhibitors went above and beyond with their display setups showcasing the latest ingredients, technology and innovation the flavor industry has to offer. Attendees were able to escape their screens to smell, taste and reconnect with colleagues while taking advantage of the opportunity to make new connections on the expo hall floor.



Be sure to explore the Flavorcon photo gallery and share your favorites on socials by using #Flavorcon2022.

Flavorcon 2022 Attendees

Have you had a chance to explore the photo gallery? Find your face, and/or the faces of your colleagues by visiting *bit.ly/3TS7Ri4*. Be sure to share your favorites by using #Flavorcon2022 and tag *P&F+* so we can repost you.

Thank you to our photography sponsor, Oamic Ingredients, and our photographer, Peter Thompson, for shooting around the clock! We have photos from the opening networking cocktail (sponsored by Sensient), the expo hall, speaker sessions and more.

If you are a flavorist who wants to tell share your flavor journey, submit a guest column or possibly be a speaker at *Flavorcon* 2023, send an email to jrimensnyder@allured.com.

Want to get a booth in the expo hall? Contact Paige Crist, pcrist@allured.com, to get started and find out about more sponsorship opportunities.



The Flavorcon 2022 expo hall was filled with the latest ingredient launches, innovative technology and even The Mad Hatter, aka Omega Ingredient's CEO, Steven Pearce.

Flavorcon 2024 Dates and Location

Mark your calendar for November 8-9, 2023, for the next *Flavorcon*! The two-day event will be returning to Cincinnati's Duke Energy Convention Center. More information to come as the event approaches. Until next time!

Meet *Perfumer & Flavorist+* 2023 Advisory Board

Discover the latest professionals added to the board.

BY JENNA RIMENSNYDER, managing editor, *Perfumer & Flavorist+*



The P&F+ advisory board is designed to assist in our mission to bring together the entire F&F supply chain.

Before we jump into 2023's advisory board line-up, *Perfumer & Flavorist+* (*P&F+*) would like to thank our 2022 advisory board members for assisting in our mission to bring together the entire F&F supply chain. Special thanks to our outgoing legacy members John Cavallo, Virginie Daniau, Matthias Guentert, Judith Michalski and Laure Moutet.

A new year calls for a revamped board. Readers will notice some familiar faces, including Darryl Do, Neha Okhade and John Wright. To add new dimension to the group, *P&F+* has ushered in some new faces to the roster, including "Organoleptic Characteristics of Flavor Materials" columnist, Cynthia (Cyndie) Lipka, Alison Freedman and Rishabh C. Kothari.

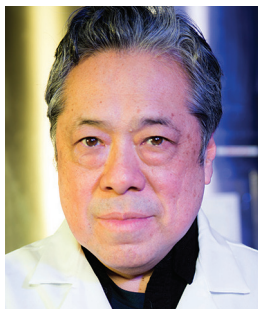
Meet the *P&F+* advisory board:

Darryl Do, perfumer, Delbia Do Fragrances

Darryl Do was born and raised in New York City and is a professional perfumer working for his family-owned business Delbia Do Fragrances. Delbia Do was established in 1968 as a fragrance and flavor creator located in the Bronx. He specializes in creating fragrances for niche brands and manufactures perfumes for many global brands as well. He speaks globally on cosmetics

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regulatory and USDA Organic compliance. Do has taught martial arts, Kenpo karate in NYC and perfumery at FIT and Kent State. He is a member of the American Society of Perfumers, Women in Flavor and Fragrances (WFFC), Cosmetic Industry Buyers & Suppliers, Fashion Group International.



Darryl Do

Alison Freedman, certified flavorist, Firmenich



Alison Freedman

Alison Freedman is a certified flavorist with Firmenich supporting Savory, Sweet and Beverage business units. She currently serves as the Society of Flavor Chemists Media Communications Chairperson. Freedman is passionate about her client-facing experience creating winning tastes, developing innovative products and advancing health-focused impacts for global food and beverage clients. She is committed to combining strategy, innovation, product development and technologies to sustainably benefit the greater good. A piece of her heart will always be in Blacksburg as a Virginia Tech grad and forever Hokie. In her free time she loves to appreciate and study wine; she is also a Level 3 certified sommelier in pursuit of Level 4 certification.

Cyndie Lipka, principal flavorist, Bell Flavors and Fragrances



Cyndie Lipka

Cyndie Lipka is a principal flavorist at Bell Flavors and Fragrances. She has been in the flavor industry for 28 years. Lipka has been an active industry member beginning with the Chemical Sources Association (CSA). She has held the presidency twice for this organization. She then joined Society of Flavor Chemists board. Lipka has served on the WFFC Board of the Chicago Chapter. She finds herself back on the CSA Board currently. Awards include the OF Stambaugh Chemistry Alumni award from Elizabethtown College in 2014 which is a Lifetime Achievement Award. In 2017 she received the WFFC Flavorist of the Year Award.

Rishabh C. Kothari, president, Fragrances and Flavours Association of India



Rishabh C. Kothari

Rishabh C. Kothari is an entrepreneur by profession and a Heartfulness meditation trainer by passion. CEO of CKC Fragrances, he is also the president of the Fragrances and Flavours Association of India (FAFAI) as well as the Business Chamber MCCI. He has also been the editor of FAFAI's quarterly publication FAFAI Journal for several years.

Neha Okhade, perfumer, Agilex Fragrances



Neha Okhade

Neha Okhade apprenticed in perfumery in India and refined her talents in Switzerland before making her journey to the United States. She joined the Agilex team in 2019 as a junior perfumer. She has over ten years of experience in the industry. Okhade draws on her personal experiences to create fragrances that resonate with emotion.

John Wright, independent flavorist and author



John Wright

John Wright has worked as a flavorist for over 30 years, initially with Duckworths and PFW in the United Kingdom, then Bush Boake Allen in Canada, the United Kingdom and the United States before joining IFF's U.S. operations. He is currently an independent consultant and the author of the technical book "Flavor Creation."

Flavor Trends:
Exploring the World of Middle Eastern Cuisine

Consumers are turning to global cuisine as a source of excitement and adventure.

BY DOUG RESH, Director, Commercial Marketing at T. Hasegawa USA



Doug Resh



While mainstream favorites like Chinese, Mexican and Italian food still dominate the global flavors category, U.S. consumers are beginning to look toward more exotic cuisines from the Mediterranean and Middle East.

After years of reduced international travel during the pandemic, it's no surprise that consumers have turned to global cuisine as a source of excitement and adventure. Even after easing travel restrictions and a return to overseas vacations, consumers still look toward globally-inspired dishes as a convenient, low-cost way to spice up life. CPG food companies and foodservice brands are responding to this shift in demand with boldly flavored new products and menu items that tap into consumers' desire for global cuisine. In fact, according to Mintel research[a], 36% of U.S. consumers would like to see more authentic international flavors in the grocery store. While mainstream favorites like

[a]*www.mintel.com/report/regional-and-international-flavors-and-ingredients-us-2022*

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Chinese, Mexican and Italian food still dominate the global flavors category, U.S. consumers are beginning to look toward more exotic cuisines from the Mediterranean and Middle East. While many of these cuisines initially gained a following in foodservice, flavors like hummus, baklava and falafel have become staples at grocery stores across North America, and the trend shows no signs of stopping.

Authentic Middle Eastern flavors are also being introduced to American consumers through fusion foods on restaurant menus, creating exciting new combinations that blend unexpected international flavors with familiar dishes. In many cases, consumers are introduced to Mediterranean and Middle Eastern flavors via fusion dishes based on a traditional American entrée with a bold sauce or condiment featuring international flavors. According to a 2022 Mintel report[b], there was a 16% increase in Greek tzatziki sauce on menus between 2018 and 2021, as operators add this richly flavored sauce to bowls, burgers, salads and other entrées. This same approach is rapidly growing for Middle Eastern flavors like za'atar, baharat, ras el hanout, sumac, harissa and others. The Middle East offers a broad range of rich flavors of cuisine from Syria, Turkey, Lebanon and Armenia, and consumers are highly interested in these foods, along with North African cuisines from Morocco, Algeria and Egypt.

Tapping into the Gen Z Appeal of International Cuisine

Interest in international flavors is being boosted by younger Millennial and Gen Z consumers, who seek diversity in their food choices and index higher in all international flavor consumption, including Middle Eastern foods. According to Mintel, today's younger generations are the most diverse in U.S. history and were raised with broader palates. More than 38% of Gen Z consumers eat Middle Eastern cuisine at restaurants and these consumers are more likely than any previous generation to find inspiration in their food choices from social media. Mintel research[c] indicates that 62% of Gen Z adults cook international cuisines at home, compared to 46% of Millennials and 23% of Gen X. Clearly, there is a major opportunity for food brands to capitalize on the immense interest in Middle Eastern flavors with younger consumers, offering a broader range of seasonings and ingredients that tap into the appeal of this cuisine.

[b]*www.mintel.com/report/us-trending-flavors-and-ingredients-in-protein-market-report*

[c]*www.mintel.com/press-centre/food-and-drink/generation-z-set-to-impact-the-future-of-food-and-drink-innovation*



Flavors like hummus, baklava and falafel have become staples at grocery stores across North America, and the trend shows no signs of stopping.



Middle Eastern foods pack a burst of flavor and offer a surprising number of vegetarian and vegan dishes like cauliflower shawarma, tabbouleh, fatteh, shakshuka and hummus.

Leveraging the Health Perceptions of Middle Eastern Cuisine

One of the greatest strengths of Middle Eastern cuisine is the implied "health halo" that these foods deliver. Rich in aromatic ingredients, herbs and spices like tahini, cumin and za'atar, Middle Eastern foods pack a burst of flavor, and offer a surprising number of vegetarian and vegan dishes like cauliflower shawarma, tabbouleh, fatteh, shakshuka and hummus. This is a key attribute that is growing the profile for Middle Eastern foods in the United States, and consumers are looking for plant-based foods. Vegetarian or "flexitarian" diets are on the rise, both for health and environmental reasons, with over 46% of U.S. adults aged 18-34 in a recent Mintel survey[d] citing that they are trying to add more plant-based foods to their diets. Many Middle Eastern cuisines feature plant-based ingredients like crushed wheat, chickpeas and lentils that offer a satisfying alternative to animal proteins, when coupled with aromatic Middle Eastern spices. Vegetarian based dishes like falafel are making the transition from foodservice menus to grocery store aisles, as they become more familiar to consumers and infused with American dishes.

The health attributes of Middle Eastern flavors represent a double opportunity for food companies and restaurants who can leverage not only the growing popularity of international foods, but also the immense demand for healthier options and plant-based or flexitarian diets.

The Growth Potential of Middle Eastern Flavors in the United States

While Middle Eastern cuisine has ancient origins and these robust dishes have been served for millennia, the category has a lot of room for growth in the U.S. market, and it is catching on quickly. As we apply new technologies to old recipes, the result is compelling, unique flavors that help expand the appeal of Middle Eastern food throughout North America. The bold international flavor of Middle Eastern cuisine is gaining mainstream acceptance in the United States, and as consumers simultaneously look for great-tasting products that deliver on consumer interest in healthier lifestyles, the role of Middle Eastern flavors will continue to grow in new product development and foodservice menus.

[d]*www.mintel.com/press-centre/food-and-drink/taste-is-the-top-reason-us-consumers-eat-plant-based-proteins*

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2-Acetyl-2-thiazoline screams corn, and in all forms—cooked, roasted, popped and in chip profiles, as there seems to be a salty aspect to this, as well!



Organoleptic Characteristics of Flavor Materials

This month's column explores the versatility of heliotropyl acetone, propyl levulinate, propyl caproate, natural and more.

BY CYNDIE LIPKA
Principal flavorist,
Bell Flavors and Fragrances

Organoleptic Evaluation Panelists

- **Bill Aslanides**, Senior Flavorist, Synergy Flavors, Inc.
- **Deborah Barber**, Senior Flavorist, FONA
- **Nicole Hernandez**, R&D Manager and Senior Flavorist, FlavorChem
- **Christina Hook**, Flavorist, Bell Flavors and Fragrances
- **Judith Michalski**, Senior Flavorist, abelei flavors
- **Andrew Petrou**, Flavorist, Savory, Bell Flavors and Fragrances

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Propyl caproate, natural

Source: Vigon
FEMA# 2949, CAS# 626-77-7
Natural occurrence: Apple, apricot, Asian pear, Parmesan, provolone, Gruyere, durian, orange juice, grapefruit juice, grape, passionfruit, paw-paw, peach, peas, rum, whiskey, wine.
Odor: @ 1%. Pineapple, fruity, waxy, slightly musty, rum, cognac, fatty, heavy, tropical and slightly cheesy.
Taste: @ 1 ppm. Soft, fruity, slightly sweet, light green, waxy.
Taste: @ 2 ppm. Waxy, fruity, pineapple, somewhat musty, sweaty, grape, floral, heavy, tropical.
Possible applications: The panel felt that this ester contributes a very nice green note for multiple uses, but particularly for tropical profiles. There were lots of mentions of pineapple, generic tropical and also guava, mango, and passionfruit. Other mentioned fruits included apple, pear, grape and strawberry. The panel also think that this would work in some aged cheeses and white wine.
➤**Vigon:** *www.vigon.com*

Propyl levulinate

Source: Sigma-Aldrich
FEMA# 4480, CAS# 645-67-0
Natural occurrence: Brandy.
Odor: @ 1%. Heavy, earthy, gassy, smoky, brown, fermented, cask-like, slightly resinous and olive-like.
Taste: @ 1 ppm. Earthy, sweet, slightly resinous, vanilla, slightly creamy.
Taste: @ 3 ppm. Sweet, creamy, brown, woody, smoky.
Possible applications: The panel felt this would work in a vanilla or cask-like environment. Maybe in maple and also in caramel or sugar cookie. It would definitely would work in rum, sherry and wine. It might be worth trying in green olive profiles.
➤**Sigma-Aldrich:** *www.sigmaaldrich.com*

Heliotropyl acetone

Source: Penta
FEMA# 2701, CAS# 55418-52-5
Not naturally occurring.
Odor: @ 1%. Slightly floral, fruity, berry and powdery, sweet, marshmallow, caramel, resinous, cooked sugar.
Taste: @ 5 ppm. Sweet, powdery, marshmallow, vanillic, berry, somewhat floral.
Taste: @ 10 ppm. Berry, floral, fruity, slightly waxy, sweet, marshmallow, cherry-like, powdery, caramelic, vanillic, resinous.
Possible applications: Firmly entrenched in the sweet category, this material can pose into different positions and profiles. There was the cherry-berry camp where this would fit well into all the berries, including the ever-popular blue raspberry. For me, this would marry well with dimethyl sulfide for ripe notes in berries. The floral aspect of this would allow it to work in floral flavors such as rose or lavender. I can even see this in bubble gum profiles. There is also a vanillic, helio aspect to this where many felt it would have a good role in caramel, vanilla, cotton candy or even a sweet cream profile. The panel also felt that this would be nice in a root beer or added to a balsamic profile.
➤**Penta:** *www.pentamfg.com*



Propyl levulinate can be used in maple and also in caramel or sugar cookie.

α-Terpinene, natural

Source: Vigon
FEMA# 3558, CAS# 99-86-5
Natural occurrence: Acerola, calabash nutmeg, California pepper, caraway, cardamom, carrot, celery, cherimoya, bergamot, bitter orange, grapefruit, kumquat, lemon, lime, mandarin, orange, tangerine, yuzu, clove, coriander, cumin, date, dill, elderberry, fennel, hazelnut, gin, ginger, grape, guava, honey, kiwi, litchi, nutmeg/mace, papaya, parsley, passionfruit, peach, pecan, black pepper, pimento, pistachio, pomegranate, potato chips, prickly pear, raspberry, rooibos, rosemary, rum, starfruit, tarragon, tea, thyme.



The panel definitely saw 2-methoxy-3-methylpyrazine as a part of peanut, roasted sesame, coffee, hazelnut, grains and for toasted and roasted notes.

Odor: @ 1%. Piney, green, distilled lime, slightly musty, lifting.
Taste: @ 1 ppm. Green, fruity, skin notes, citrus.
Taste: @ 2 ppm. Fresh, green, lime, pine, mango.
Possible applications: This terpene is found in lots of places and I think can be adapted to the environment, too. At lower levels, I can see this in multiple fruits for skin notes—such as white or green grape, apple, pear and mango. But at higher levels, this terpene can hold its own in citrus, especially limes and specifically distilled lime. So, naturally, let's also think of things like cola and gin! Many panelists felt that this material would also work nicely in different herbs and spices, such as oregano, cumin, rosemary and fresh dill. The vegetables that the panel mentioned included carrot and green pepper.
➤**Vigon:** *www.vigon.com*

2-Methoxy-3-methylpyrazine

Source: Synerzine
FEMA# 3183, CAS# 2847-30-5
Natural occurrence: Krill, shrimp.
Odor: @ 1%. Nutty, musty, earthy, raw, sweet, intense, brown, roasted, coffee, cocoa, bready.
Taste: @ 1 ppm. Nutty, toasted, brown.
Taste: @ 2 ppm. Nutty, bitter, earthy, slightly shrimpy, strong, brown, toasted, peanut.
Possible applications: The panel definitely saw this as a part of peanut, roasted sesame, coffee, hazelnut, grains and for toasted and roasted notes. This is the single isomer, so it is different from the blend normally thought of with thinking of 3183. Since this is a natural, you might try this at half the level of 2-acetyl pyrazine as a substitute!
➤**Synerzine:** *www.synerzine.com*

2-Acetyl-2-thiazoline

Source: Sigma-Aldrich
FEMA# 3817, CAS# 29926-41-8
Natural occurrence: Beef, cheddar, chicken, orange, corn, lamb, litchi, cream, skim milk, mustard, peanut, pistachio, sesame seed, salami, shrimp, tea, wheat.
Odor: @ 0.1%. Toasted, corn-like, cereal, fatty, oily, nutty, baked, graham cracker, potato/corn chips.
Taste: @ 0.1 ppm. Brown, toasted, cooked, crusty, baked, sweet, nutty, corn, fatty, oily, grain, salty.
Taste: @ 0.2 ppm. Sweet, brown, corn, nutty, toasted cereal, slightly meaty, graham cracker, cooked.
Possible applications: This compound sort of screams corn, and in all forms—cooked, roasted, popped and in chip profiles, as there seems to be a salty aspect to this, as well! But when you look past that, there is much more to the profile, and at low levels, can be used as a toasted and roasted note. Many nut profiles came to mind, such as almond, hazelnut, pistachio, peanut, cashew and also sesame seed. This might bear remembering with the new allergen list.
➤**Sigma-Aldrich:** *www.sigmaaldrich.com*

cis-6-Nonen-1-ol

Source: Synerzine
FEMA# 3465, CAS# 35854-86-5
Natural occurrence: Cucumber, fish, litchi, musk melon, watermelon, pepino.
Odor: @ 0.1%. Green, waxy, pulpy, sweet, slightly earthy, vegetative, cucumber.
Taste: @ 0.1 ppm. Green, sweet, fresh, melon, pulpy, waxy, fatty, some mouthfeel.
Taste: @ 0.2 ppm. Green, sweet, waxy, pulpy, cucumber, fresh, fruity, with a fatty body.
Possible applications: At really low levels, such as 0.1 ppm, this alcohol would function nicely in peach or nectarine flavors, mango and, at an even lower level, may work nicely in tomato. At slightly higher levels, it would work in apple, pear and papaya. At even higher levels, it functions nicely in cantaloupe, honeydew, watermelon and cucumber flavors. This might also work in raw jicama, potato and other fresh vegetables.
➤**Synerzine:** *www.synerzine.com*

(Z)-4-Decenal, 4-Decenal

Source: Bedoukian
FEMA# 3264, CAS# 21662-09-9
Natural occurrence: Caraway, cardamom, chicken, mandarin, orange, yuzu, clam, coriander, potato, tomato.
Odor: @ 0.1%. Cardamom, mandarin, green, sharp, citrus peel, cilantro, floral, fatty, waxy, brothy, chicken, pork, rich.
Taste: @ 0.1 ppm. Green, fatty, coriander, melon, cardamom, potato, orange, mandarin, chicken fat drippings, brothy.
Taste: @ 0.2 ppm. Very strong, aldehydic, fatty, waxy, lots of mouthfeel, cheesy, sweaty, earthy, potato, brothy, chicken, pork, very rich.
Possible applications: Well, it seems like the panel was either volatile when you read those sensory attributes or spot on! The only items we failed to mention were the clam and tomato when you compare against the naturally occurring list. Bedoukian calls this cardamom aldehyde and this is surely one of the reasons why I love cardamom!
➤**Bedoukian:** *www.bedoukian.com*

O-(Methylthio)phenol

Source: Synerzine
FEMA# 3210, CAS# 1073-29-6
Natural occurrence: Coffee.
Odor: @ 0.1%. Smoky, brown, phenolic, coffee, cocoa, bacon, rubbery.
Taste: @ 0.1 ppm. Brown, toasted, smoky, vanillic, phenolic, rubbery.
Taste: @ 0.2 ppm. Coffee, brown, smoky, rubbery, phenolic.
Possible applications: It's not surprising that this phenol has the characteristics listed above. It's found in coffee and has a home there. The panel also felt this could play a role in smoke replacers and could be used for roasted garlic or onion notes, ham and bacon.
➤**Synerzine:** *www.synerzine.com*

2-Ethyl fenchol

Source: Bedoukian
FEMA# 3491, CAS# 18368-91-7
Not naturally occurring.
Odor: @ 0.01%. Earthy, musty, damp, camphoraceous, beets, piney, thyme, mushroom.
Taste: @ 0.01 ppm. Earthy, carrot, rooty, green, damp, musty, camphoraceous.
Taste: @ 0.02 ppm. Musty, earthy, mushroom, rooty, beet, pine.
Possible applications: Look at those use levels! At 10 ppb, we can detect this with decent impact. The panel came up with an array of profiles where this would fit. Vegetables include beets, potato, mushroom, truffles, carrot, turnips and hummus. We also felt that this would work in Brazil nuts and black walnut. Shrimp, lobster and catfish came up as options, as well. A mention of mold made me think of blue cheese.
➤**Bedoukian:** *www.bedoukian.com*



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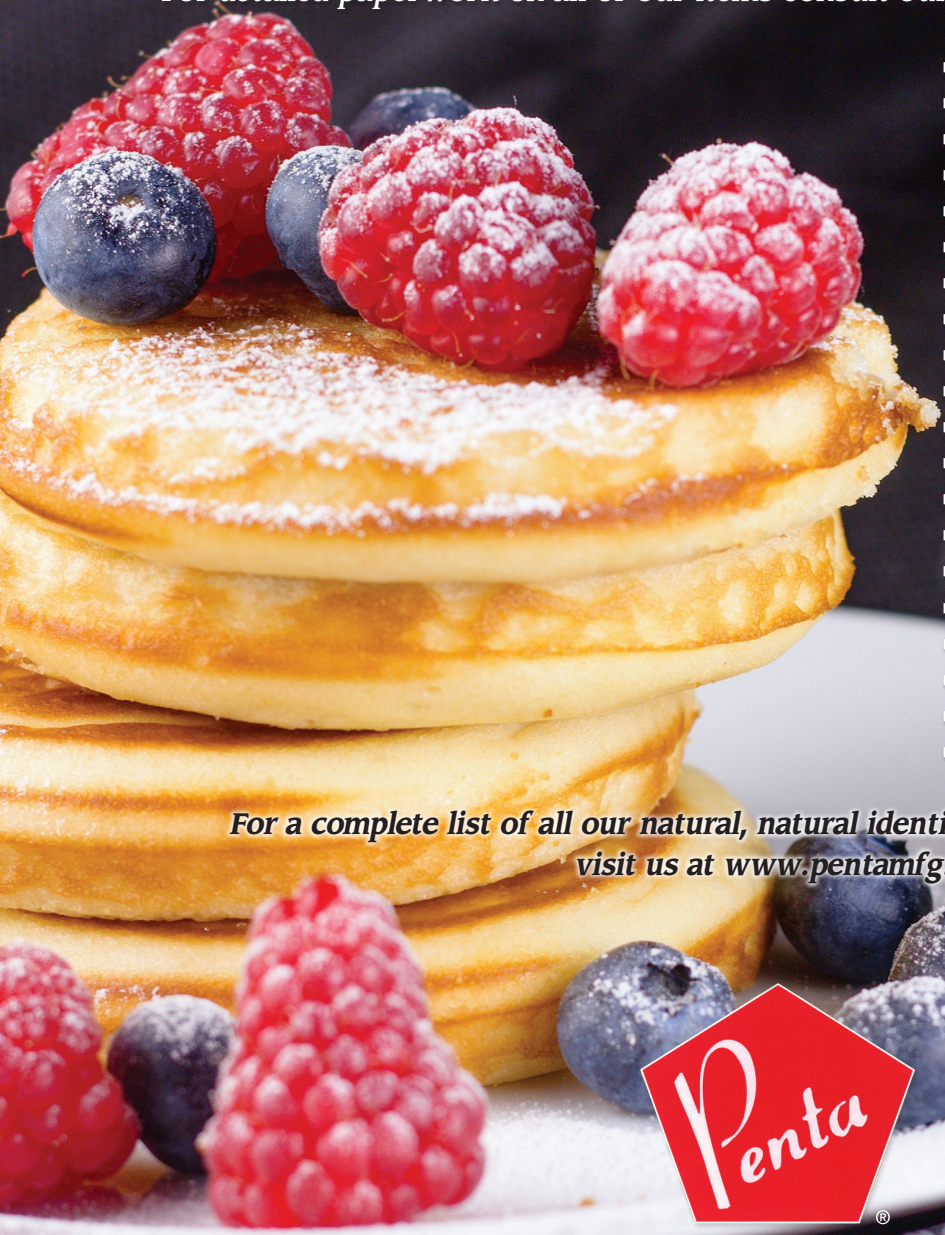
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