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F&F 2026: Volatility, Velocity and the Great Portfolio Reset

What recent year-end results and early 2026 moves tell us about where the industry is heading.



While fine fragrance and high-margin innovation continue to drive top-line growth, the sector is grappling with intensifying climate risks and a fundamental structural re-centering toward emerging markets.

The 2025 year-end results and early 2026 strategic maneuvers reveal a flavor and fragrance (F&F) industry operating in a bifurcated reality. While fine fragrance and high-margin innovation continue to drive top-line growth, the sector is grappling with intensifying climate risks and a fundamental structural re-centering toward emerging markets.

The Climate Factor: From Theory to Profit Drag

Perhaps the most sobering takeaway for insiders is the tangible impact of climate volatility on the bottom line. Sensient Technologies closed 2025 under significant pressure, with Q4 operating income in its Flavors & Extracts Group falling 10.0%. While volume softness in agricultural ingredients played a role, the standout detail was a $3 million one-time charge tied to severe "atmospheric river" events. This serves as a definitive reminder that weather-related disruptions are no longer "tail risks"—they are active denting factors in production and harvest reliability.

A Tale of Two Portfolios: Specialization vs. Divestment

We are witnessing a massive "portfolio reset" as the industry's titans narrow their focus. dsm-firmenich, now a focused nutrition, health, and beauty leader following its 2.2 billion euro divestment of Animal Nutrition & Health, saw 3% organic sales growth in 2025. Similarly, IFF has launched a formal sale of its Food Ingredients segment (valued at $3.28 billion in 2025 sales) to sharpen its focus on higher-value businesses.

The message is clear: the industry is moving away from low-margin commodities toward specialized, high-impact categories. Fine fragrance



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remains the undeniable star, delivering double-digit growth for IFF and leading dsm-firmenich's Perfumery & Beauty unit.

Regional Hubs: Riyadh, Grasse and Mexico

Strategic investments are increasingly "in the region, for the region."

- The Middle East Hub: dsm-firmenich's opening of the Po ONE Lab in Riyadh signals Saudi Arabia's emergence as a creative hub for global fine fragrance. The lab aims to bridge regional heritage with modern science, supporting a new generation of local luxury brands.
- The Natural Origin Center: Givaudan is returning to its roots with a CHF 55 million investment in "Campus 52" in Grasse, France. This center of excellence will hub its House of Naturals organization, focusing on agronomy and innovation for natural fragrance ingredients.
- Latin American Scaling: Simultaneously, Givaudan is investing $110 million in a new facility in Pedro Escobedo, Mexico, designed to support up to 25,000 tons of capacity for the Andean and Caribbean markets.

2026 Outlook: Productivity as Paramount

Heading into 2026, guidance from IFF and Sensient suggests that volume recovery is the primary variable. IFF expects adjusted EBITDA growth of **3-8%**, outpacing its projected top-line growth. For the industry insider, the signals for the coming year are unmistakable: productivity gains must offset agricultural volatility, premium scent categories will continue to over-perform, and the geographical center of gravity is shifting toward regional centers of excellence.



Ingredients

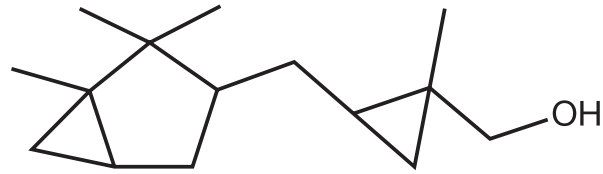


Anisyl Propionate Brings Luscious Sweetness and Modern Anise Sophistication to Flavor Creation

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Avant Organics introduces anisyl propionate (FEMA# 2102), a refined anisic material delivering luscious, mouthwatering sweetness with contemporary sophistication. It opens with a soft, candy-like anise note - smooth and velvety rather than sharp - layered with juicy nuances of cherry, almond, and red berry. A delicate floral shimmer reminiscent of hawthorn and honey blossom brightens the profile, while a creamy, subtly vanillic warmth rounds the body with comforting sweetness. In flavor applications, anisyl propionate provides a polished confectionery lift to cherry, cola, root beer, licorice and berry profiles. Used at low levels, it acts as a sweetness amplifier and flavor harmonizer - enhancing juiciness, softening edges, and adding cohesive depth without overpowering the composition. A gentle balsamic undertone supports top-note sparkle while contributing a smooth, sweet, and lingering finish. Avant Organics provides this material as EU natural, kosher and non-GMO. For your free sample please email info@avantorganics.com.



Hangzhou Grascent Launches Islandol, a Powerful Sandalwood Aroma Ingredient

Hangzhou Grascent Co., Ltd.

www.hangzhougrascent.com

Hangzhou Grascent Co., Ltd. has introduced Islandol (1-methyl-2-(1,2,2-trimethylbicyclo[3.1.0]hex-3-ylmethyl)cyclopropyl)methanol), a sandalwood aroma ingredient with a woody, creamy, rosy profile. It is recommended at trace levels up to 2% for fine fragrance, personal care, fabric care and home care applications.



Less Cocoa, Same Indulgence

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https://www.vigon.com/product/cocoa-extender-nat/

Cocoa Extender Nat, item #600547, helps formulators address cocoa supply and cost challenges while maintaining a rich, roasted cocoa profile. With cocoa undertones, mild bitterness, and subtle astringency. It supports reduced cocoa usage while delivering indulgent chocolate flavor across a range of applications.

- Taste and odor characteristics: Dark roasted coffee profile with cocoa undertones and a balanced hint of bitterness and astringency.
- Suggested applications: This innovative ingredient amplifies the deep, indulgent cocoa notes that often fade with cocoa powder reduction

Images courtesy of the manufacturers



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https://www.isobionics.com/global/en/product-finder/natural-alpha-farnesene-95

With a high purity of 95%, Isobionics' natural alpha-farnesene 95 (FEMA# 3839) is produced using cutting-edge fermentation technology. It performs exceptionally well in lime oil applications and fruit flavors, particularly in the citrus family. It has a vegetable odor with a celery note followed by sappy, stem-like notes and fruit skin.



ALICE REBECK



Alice Rebeck, senior perfumer, Agilex Fragrances

Name: Alice Rebeck

Title: Senior Perfumer

Location: Piscataway, New Jersey, USA

What led you to the fragrance industry?

Fate! I answered an ad for a Lab Tech… It happened to be in a flavor lab. That got me started in this business.

Can you share a defining moment or breakthrough in your career as a perfumer?

More fate! When my next company was acquired by a flavor and fragrance company, I was given the choice of transferring to the GC lab of the fragrance division or moving to Indianapolis to stay in flavors. I chose to stay put. The raw materials were mainly the same, and smelled the same. I just had to get used to sticking the blotter in my nose instead of my mouth.

What were some of the biggest challenges you faced when entering the perfume industry, and how did you overcome them?

My biggest challenge was the "Good ol' Boys" club. Don't laugh. Anyone who wasn't working 50 years ago has no idea what it was like for a woman in any position other than menial or administrative. We were OK as minions, but not managers.

What changed that? I hate to sound like a preview of a Lifetime movie, but the EEOC and NOW slowly changed attitudes about women in the workforce.

Can you describe a time when a fragrance formulation didn't turn out as expected? How did you address the issue?

Unexpected outcomes happen all the time. It is addressed by checking the formula for silly mistakes and then trying a new combination. People look at fragrance as an art, but its roots are firmly based in science. Sometimes unexpected reactions happen, like a purple colored oil. Trial and effect are critical to fragrance development and perfumer training.

How do you find the right balance between artistic expression and the technical limitations of perfume formulation?

Technical limitations are dictated as much by regulatory restrictions as the technical requirements of an application. There is as much, if not more, creativity in technical and regulatory revisions as there is in initial formulation. A perfumer has to know each ingredient, the odor profile, volatility, solubility and relative strength, to be able to make a stable, compliant, effective fragrance.

Are there specific skills or knowledge areas you believe are crucial for a perfumer to master?

Chemistry and math. Like it or not, fragrances are made up of molecules, both natural and synthetic. Without knowledge of how these molecules can interact the perfumer is handicapped. We don't need a PHD in chemistry, but basic principles are necessary. You don't have to be able to write the molecular formula but you need to know things like: aldehydes and amines react violently sometimes.

Click above to play

Courtesy of Agilex Fragrances

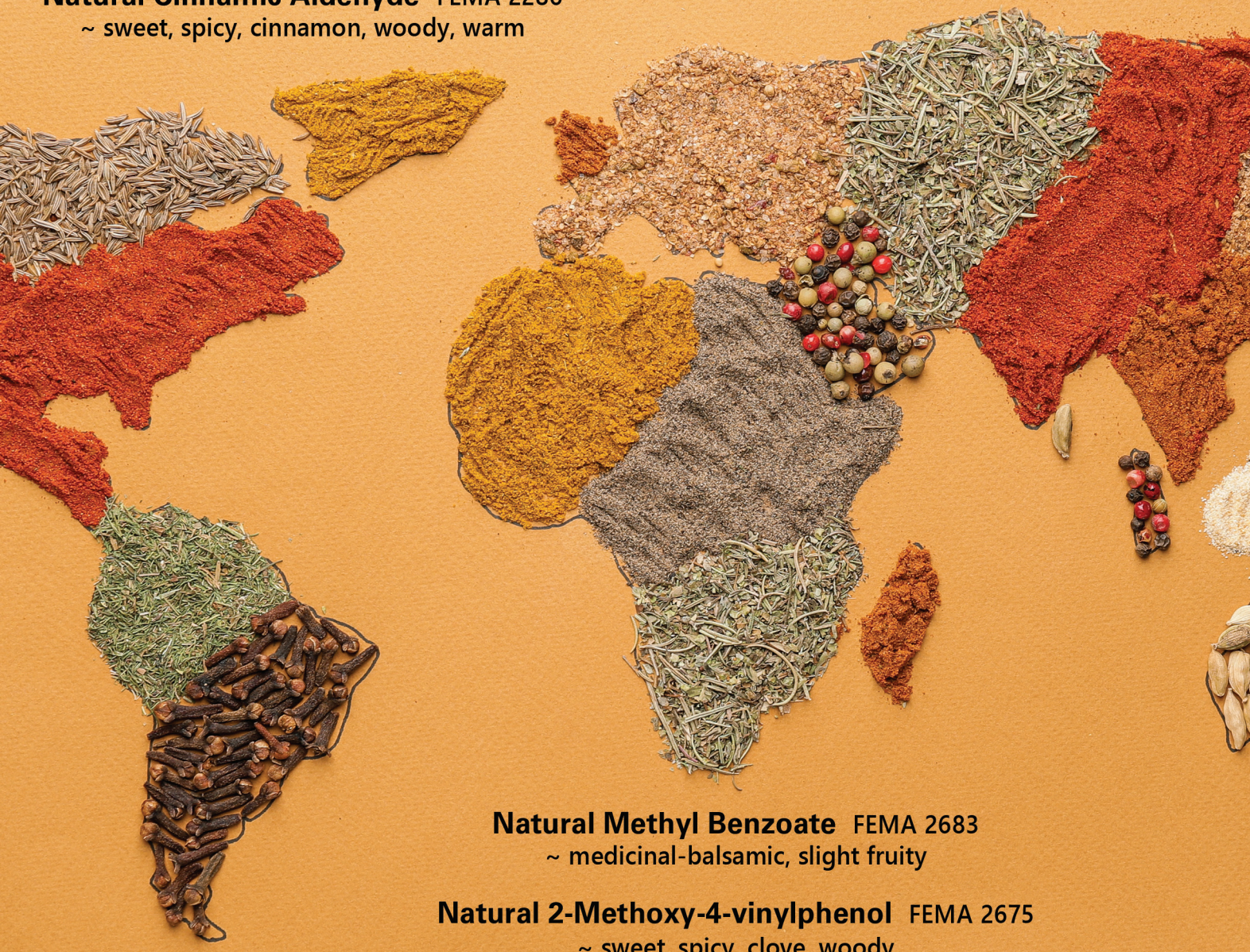
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2-Butylfuran is effective in all seafood flavors. The best level of addition in shrimp, lobster and related flavors runs from eighty up to one hundred ppm.



BY JOHN WRIGHT
johnwrightflavorist@gmail.com

2-Butylfuran: The Subtle Art of Authenticity

2-Butylfuran (FEMA# 4081, CAS# 4466-24-4, DG SANTE No.13.103) is found very widely in nature, in food categories ranging from cooked savory to fresh fruits. The odor of 2-butylfuran is unusual, combining a bright ethereal note with a fruity pineapple background.

As a flavor ingredient it is not over powerful and never plays a vital role as a character recognition foundation. Instead, it subtly helps add authenticity to the background of many diverse flavor profiles.

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.

Savory Flavors

Bacon: Bacon flavors are all too often dominated by one ingredient and to say they lack complexity is a severe understatement. Fifty ppm of 2-butylfuran brightens and helps fill out the profile.

Beef, roast: Roast beef flavors rarely fall into the same simplicity trap but 2-butylfuran still adds a welcome background note at one hundred ppm.

Chicken: Similar comments apply to all styles of chicken flavors and the same suggested level of 100 ppm works well.

Crab: Crab flavors can be assisted by the added complexity and lift provided by 2-butylfuran at levels of addition in the region of 40 ppm.

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Egg, boiled: Boiled egg flavors are rarely overpowering and the level of addition of this raw material reflects that at around 20 ppm.

Fish, white, cooked: A similarly subtle level, 30 ppm, works well in all non-oily fish flavors.

Lamb: 2-Butylfuran helps lift the fatty profile of lamb flavors. Fifty to 100 ppm is a good range of addition.

Miso: Miso is a fairly subtle food ingredient and 10 ppm of 2-butylfuran helps brighten the top notes of miso flavors.

Pork: Levels can vary in pork flavors but, generally, fall within the range of 50-100 ppm.

Potato, fries: The ethereal note of 2-butylfuran helps soften some of the harsher notes of fried potatoes, without diminishing impact.

Rice, cooked: Cooked rice flavors fall well within the subtle category, but do tend to have one dominant ingredient. A touch, around 10 ppm, of 2-butylfuran is modestly helpful.

Shrimp and lobster: 2-Butylfuran is effective in all seafood flavors. The best level of addition in shrimp, lobster and related flavors runs from 80 ppm up to 100 ppm.

Tomato: Thirty ppm of 2-butylfuran lifts all tomato flavors. It works equally well in fresh and processed profiles.

Brown Flavors

Cocoa: 2-Butylfuran is as widely applicable to brown flavors as it is to savory flavors. Cocoa is a good example. Eighty ppm adds brightness and lift.



Given the instability of key sulfur notes, the main challenge with coffee flavors is to achieve freshness. 2-Butylfuran helps at 50 ppm.

Coffee: Given the instability of key sulfur notes, the main challenge with coffee flavors is to achieve freshness. This ingredient helps at 50 ppm.

Licorice: Licorice flavors can also be helped by a little extra lift. Fifty ppm of 2-butylfuran is subtly helpful.

Malt: Twenty ppm adds a little complexity and softens the harshness of methional in malt and malted milk flavors.

Tea: This raw material is important in all tea flavors, but more central to black tea profiles. Levels of addition range from 20 ppm in green tea flavors up to 100 ppm in black tea and Darjeeling flavors.

Vanilla bean: Fruity and ethereal notes both enhance realistic vanilla bean flavors. The ideal level of addition reflects this at around 400 ppm.

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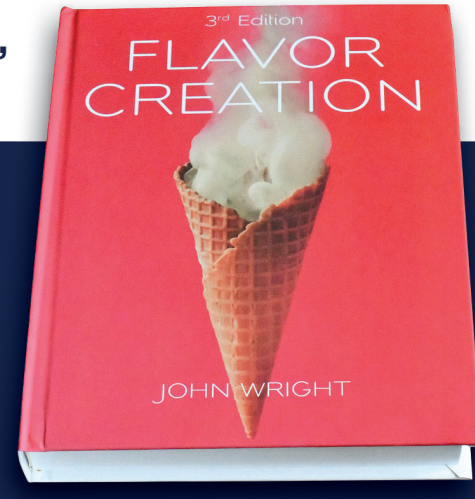


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Nut Flavors

Almond and pistachio: 2-Butylfuran plays a useful part in all nut flavors. The level of addition is most subtle in almond and pistachio flavors, at 40 ppm.

Hazelnut: Hazelnut flavors can accommodate higher levels, up to 100 ppm.

Peanut: Peanut flavors can make good use of a range of levels of 2-butylfuran, from 50 ppm to 100 ppm, depending on the degree of roast.

Walnut: Sixty ppm is a good level in walnut flavors, enhancing the brighter profile.

Dairy Flavors

Butter: 2-Butylfuran can work in all dairy flavors, but it is far more effective in flavor profiles that reflect some level of the effects of heat. Cooked butter flavors can take up to 100 ppm, adding brightness.

Cheese, toasted: The same comments apply to cheese flavors, where 100 ppm is also a good level.

Milk, condensed: Fifty ppm of 2-butylfuran works well in most condensed milk flavor profiles, but this can be hiked to 100 ppm if the profile is more rustic.

Fruit Flavors

Cranberry, guava, lychee, mango, strawberry and watermelon: This ingredient is not obviously aligned to fresh fruit flavors. Nevertheless, 20 ppm can work well as a subtle ethereal top note in many diverse profiles.

Passionfruit: Higher levels, around 80 ppm are, understandably, more effective in passionfruit flavors.



Fifty ppm of 2-butylfuran works well in most condensed milk flavor profiles, but this can be hiked to 100 ppm if the profile is more rustic.

Other Flavors

Honey: Honey flavors often settle comfortably into a fairly heavy profile. A tiny addition, around 10 ppm, of 2-butylfuran brightens things.

Peppermint: 2-Butylfuran also brightens peppermint flavors at levels around 20 ppm.

Spearmint: The effect in spearmint flavors is identical, as is the ideal level, 20 ppm.

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Flavor Agility: Mastering the



Social media is compressing adoption times, leaving flavor, food and beverage developers a short window to react.

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Rapid-Fire Innovation Cycle



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BY PIERRE BATTU, Managing Director, Asia, OSF Flavors

As seen with the popularity of Dubai chocolate and angel hair chocolate, viral social media videos are driving flavor trends. And the impact of such videos will only grow in 2026. So how can the industry best position itself to stay on top of these trends and keep pace with the accelerated rate of global adoption they are producing?

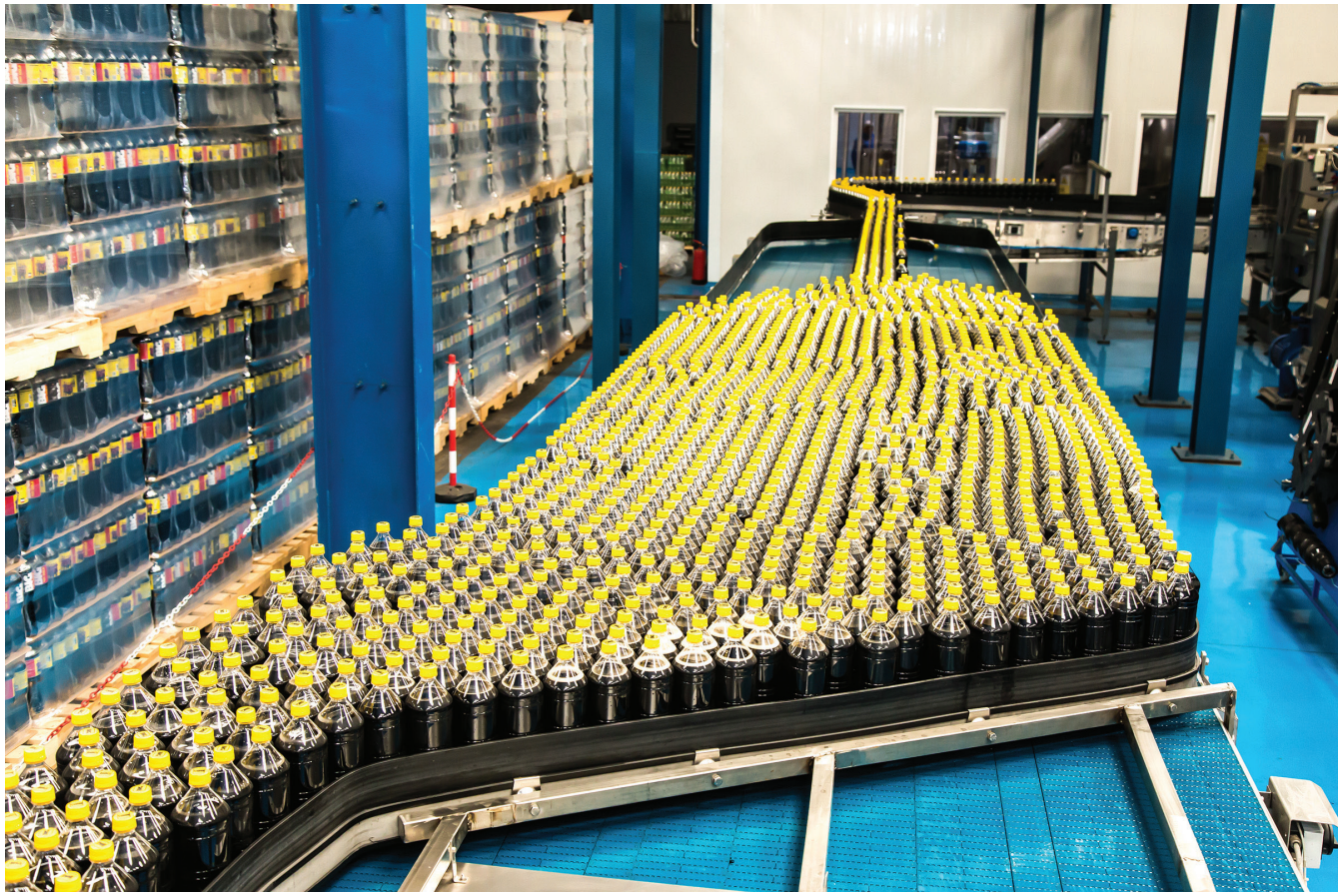
Listen Up: How to Catch Flavor Trends Before They Go Viral

Trends emerge and become amplified quickly, increasing the pressure on flavor development to move with speed. That means having a robust and ongoing listening system in place to identify potential trends as they emerge.

Social media listening plays a key role here, not only to identify emerging signals, such as viral recipes or menu mentions, but also to help validate product concept



As seen with the popularity of Dubai chocolate and angel hair chocolate, viral social media videos are driving flavor trends.



Social media is compressing adoption times, leaving flavor, food and beverage developers a short window to react.

validation. Use of a post, video or hashtag to gauge consumer interaction can help confirm a trend or potential product interest in a matter of weeks, compared to the months required with formal product testing.

On the ground, listening in global markets is also critical.

Having teams on multiple continents, for instance, can allow organizations to monitor emerging trends in real time from different cultural perspectives. This perspective can be critical as it enables quick evaluation of the global relevance of a trend once it is spotted—whether through social media chatter, local influencers, or in conversations with clients, experts or media—and to assess its potential to resonate across markets.

Agility in Action: Fast-Tracking Food & Beverage Innovation

Social media is compressing adoption times, leaving flavor, food and beverage developers a short window to react.

Agility is key. To move fast, develop ad hoc project teams comprising marketing, R&D and sensory experts to enable you to transition rapidly from identification to concept development and testing. This will help shorten the innovation cycle and increase the odds of timely launches.

Also, make sure sales teams are working in direct contact with global marketing to help insights move instantly from the field to the lab. Artificial intelligence further accelerates this process, reducing the time needed to analyze trends and cross-reference data.

Continuous innovation is critical in an increasingly competitive landscape. Today, brands that want to keep the conversation alive with consumers can't rely solely on long-cycle innovation—they also need a steady rhythm of renewal.

Seasonal or limited-time launches are a good illustration of this. Starbucks' recurring seasonal programs, for example, show how short-term innovation can sustain brand engagement while reinforcing longer-term platforms. These launches don't replace

Image by Sherif at Adobe Stock

core innovation; they complement it by creating anticipation and relevance throughout the year.

Beyond the Gimmick: The Art and Science of Trend-Driven Flavor Innovation

The development of a trend-inspired flavor is as much about creativity as it is scientific expertise. To succeed, you need an understanding of what makes a trend appealing and how to translate that into a flavor experience that feels authentic and exciting.



The development of a trend-inspired flavor is as much about creativity as it is scientific expertise.

The difference between a short-lived marketing gimmick and a lasting market success is that it can translate not only the true organoleptic components of a trend, but also its production constraints, into a finished product that meets the highest production standards and is representative of the trend experience in the consumer's eye.

Getting the flavor right so that it is evocative and representative of the original product driving the trend is critical. But brands will also need to build a full sensory experience by bridging flavor with texture and creative packaging to truly convert the experience consumers enjoy in these videos.

Social media has flattened the global flavor landscape, giving younger audiences instant access to tastes from around the world, and breathing new life into dormant local traditions. As this dynamic intensifies, trends will go global in months. That velocity will demand faster decision-making and sharper execution across the entire value chain.

Flavor manufacturers play a key role here when they combine social-media listening with true global exposure, allowing them to synthesize trends at a global level and translate them locally, so each region benefits from ideas emerging in other markets.

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"Swicy," a portmanteau of "sweet" and "spicy," has been trending since 2022. Its proliferation is apparent across multiple food and beverage products and continues to grow.



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The Scoville Surge: Why 'Swicy' is Just the Start

Condiments and sauces lead the charge, beverages heat up, and candy joins the spicy movement in our latest Forward Thinking column.

The heat is on. Spicy flavor innovation is surging, driven by adventurous consumers—80% of whom specifically seek spicy sensations—and a younger demographic that demands constant evolution beyond simple heat. This research, from regular contributor Amy Marks-McGee, uncovers the latest trends, from the ubiquitous "swicy" (sweet + spicy) to the emerging "swangy" (spicy + sweet + tangy) and "fricy" (fruity + spicy), providing food and beverage developers, flavor chemists, and food scientists with critical insights on how to layer complexity, leverage global influences, and capitalize on key application areas: condiments, sauces, beverages, and confectionery. -Editor

According to FMCG Gurus' consumer insights,[a] 80% of adventurous eaters specifically seek spicy sensations. Datassential[b] states, "Spicy food trends reflect sophisticated flavor development, moving beyond simple 'hot sauce added' approaches to integrated spicy food experiences that enhance rather than overpower core

[a]*https://www.supplysidefbj.com/colors-flavors/bold-flavor-profiles-drive-consumer-engagement-across-indulgent-categories*
[b]*https://datassential.com/resource/spicy-food-trends/*

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flavors." Interestingly, Datassential found that younger demographics experience faster spicy food trend fatigue and migrate to newer spicy trends as previous favorites go mainstream. "Swicy," a portmanteau of "sweet" and "spicy," has been trending since 2022. Its proliferation is apparent across multiple food and beverage products and continues to grow. Hot honey sparked the swicy movement. Over the past four years, hot honey has surged by 230% on U.S. restaurant menus, per Datassential[c]. According to Tastewise[d], social conversations about swicy have increased by 63.35% year-over-year. Kalsec's research[e] discovered that 62% of consumers seek sweet and spicy (swicy) combinations, followed by tangy (53%), salty (51%), and sour (48%) flavors. Condiments and sauces lead the charge, beverages heat up, and candy joins the spicy movement as three key applications driving spicy flavor innovation.

Condiments and Sauces Are A Gateway To Spicy Flavors

Condiments and sauces are a gateway to spicy flavors and experimentation because consumers can customize how much and where to use them. Hot sauces deliver layered complexity and contrast, balancing sweet, smoky, acidic, tangy, and earthy notes. Circana's survey[f] of 1,000 Americans found that 34% consider themselves "hot sauce connoisseurs," and over half (51%) of Gen Z classify themselves as one. According to Polaris Market Research[g], the global hot sauce market was valued at $3.79 billion in 2025 and is projected to reach $7.75 billion by 2034, with a CAGR of 8.55%. Many spices and spice blends originate from diverse global regions, including Asia, Africa, South America, the Middle East, the Caribbean, and the Mediterranean. McCormick identified the Sauce from Somewhere trend in its 2026 Flavor Forecast[h], which is "about embracing and highlighting sauces, dips, chutneys, and spreads with global influence." Similarly, the National Restaurant Association's What's Hot 2026 Culinary Forecast[i] reported "Consumers want to spice up their meat, seafood, and tofu with chili-lime, gochujang, and even super-spicy ghost pepper hot honey."

Brands are developing an array of spicy global flavors for condiments and sauces. Honest Bowl debuted a new line of Fairtrade Asian-inspired condiments, including Gochujang BBQ Sauce, Sriracha Mayo, and Thai Ginger Mayo varieties.

Frankie Gaw, known as Little Fat Boy, the online recipe creator and food writer, teamed up with Fly By Jing to launch Chili Crisp Ketchup. "It merges two beloved condiments for a sauce," and features maple syrup, seaweed powder, sesame oil, shallots, mushroom powder, soy sauce, peppercorns, and Sichuan chili crisps. La Victoria added a new line of topping sauces to its Mexican-inspired flavor portfolio in three varieties: Chipotle Sauce, Fiery Jalapeño Sauce, and Sweet & Spicy Sauce. Morehouse Foods, Inc. collaborated with Tapatío Foods LLC to launch Tapatío Spicy Yellow Mustard available at select Walmart retailers and online at Amazon. Trader Joe's unveiled a Bird's Eye Chile Hot Sauce, also known as peri-peri, which originates in South Africa. McCormick named Aji Amarillo the 2025 Flavor of the Year. For a limited-time this year, McCormick introduced Aji Amarillo Hot Sauce, which "blends tangy heat and fruity sweetness from Peruvian yellow chile peppers and sweet pineapple." Buffalo Wild Wings and the Marzetti Company partnered to introduce four new hot sauces inspired by the bold flavors used at Buffalo Wild Wings restaurants. The Buffalo Wild Wings Hot Sauces are available in four varieties: Blazin', Chipotle, Habanero, and Original. For Game Day, Frank's RedHot added three Wing Sauce flavors: Garlic Parmesan, Pineapple Hawaiian, and Spicy Maple. Additionally, Ghost Pepper



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Image courtesy of Honest Bowl

[c] *https://datassential.com/resource/flavor-trends-hot-honey/*
[d] *https://tastewise.io/foodtrends/swicy*
[e] *https://www.kalsec.com/natural-flavor-ingredients/insights/spicy-food-more-than-trend*
[f] *https://www.circana.com/post/hot-sauce-market-trends*
[g] *https://www.polarismarketresearch.com/industry-analysis/hot-sauce-market*
[h] *https://www.foodservicedirector.com/food-beverage-trends/the-mccormick-for-chefs-flavor-forecast-for-2026-is-here*
[i] *https://restaurant.org/education-and-resources/resource-library/what%E2%80%99s-hot-in-2026-comfort-health-and-value/*

Ranch joined the lineup of Frank's RedHot Squeeze Sauces. Smucker's will release Sweet Heat Honey in May 2026, exclusively through their food service distributors. Lid & Ladle by Sur La Table[j] Sweet Heat & Complex Condiments 2026 trend states, "Condiments are doing more work in the kitchen. Sweet heat-think chili crunch, mango-habanero sauces, and the next evolution of hot honey adds instant personality and layered flavor to simple meals."

Quick Service Restaurants Get Saucy

Sauces are a key to quick service restaurants' (QSR) menus. QSRs have been upping their sauce game with a variety of sauce launches, many of which are spicy. Datassential's research[k] finds that 3 in 5 consumers are interested in signature sauces, condiments, or dressings at restaurants, with more than half specifically craving signature sauces (52%). Moreover, Technomic's 2024 Flavor Consumer Trend Report[l] reveals that 34% of consumers prioritize a restaurant's sauce and condiment offerings when choosing where to dine. Among millennials and Gen Z, 1 in 4 say they pack their own condiments, especially hot sauce, when visiting a restaurant. Sauces stand out as everyday excitement-drivers, with Yum! Brands' 2026 What's Next in Dining report[m] showing they are 2.4 times more likely to spark consumer excitement than other food items.

Nestlé USA's 2026 Food & Beverage Trends report[n] identified "Swangy" & "Swavory:" The Next Wave of Heat as a key 2026 trend, signaling a broader spectrum of flavor. The report points to new heat profiles that add depth, including "swangy" (spicy + sweet + tangy) and "swavory" (spicy + sweet + savory). QSRs are leaning in and introducing a variety of fiery flavor profiles. For example, at the end of 2024, Yum! Brands, parent company of KFC, launched "Saucy," a new fast-casual concept focusing on chicken tenders and 11 signature sauces, inspired by its 11 herbs and spices. In October 2025, the brand introduced a salad option, and Caesar joined the sauce menu. Of the 12 sauces offered, three are spicy–Jalapeno Pesto Ranch, Korean Sweet Heat, and Thai Sweet 'N Spicy. The original location is in Orlando, Florida, and Yum! Brands has since added three more units in Orlando, one in Tampa, with further expansion in the pipeline.

In August 2025, for a limited-time, Panda Express unveiled the Dynamite Sweet & Sour Chicken in partnership with Buldak, the global No. 1 spicy noodle brand from Samyang. The collaboration marks Buldak's first-ever U.S. partnership with a restaurant brand. In October

[j] *https://learn.surlatable.com/2026-flavor-trends-we-cant-wait-to-test-try/*
[k] *https://datassential.com/resource/food-trends-sauce-trends-signature-sauces-2025/*
[l] *https://fortune.com/2025/03/12/1-in-4-gen-z-and-millennials-say-they-bring-their-own-condiments-to-restaurants-especially-hot-sauce/*

[m] *https://www.yum.com/wps/portal/yumbrands/Yumbrands/news/press-releases/from+craveable+drinks+to+sauce+rituals+yum+brands+unveils+its+first-ever+food+trends+report*
[n] *https://www.nestleusa.com/stories/new-kitchen-trends-2026*





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Image courtesy of Yum! Brands

2025, Taco Bell brought back Crispy Chicken classics, including a Burrito, Soft Taco, Strips, and Nacho Fries. The launch was accompanied by Frank's RedHot Diablo sauce, "a creamy mashup of the original Buffalo flavor, Taco Bell's signature Diablo sauce, and spicy ranch." In January, Taco Bell expanded its hot sauce offerings with the Volcano sauce. This sauce is "an evolution of its fan-favorite Lava sauce, billed as a creamy blend of cheese and spices and even more of a kick than its beloved predecessor." Chipotle rolled out a Red Chimichurri sauce in the U.S. and Canada during fall 2025. The tangy, garlicky, and spicy sauce is made with roasted garlic, fresh cilantro, chili peppers, and citrus. At the beginning of the year, Wingstop offered a "Hot Honey Trio" to introduce its new Saucy Sriracha Hot Honey and Sweet Garlic Hot Honey sauces with the original Hot Honey Rub. Technomic[o] predicts that the ubiquitous "swicy" trend will continue to evolve in 2026, resulting in additional flavor mashups like "colapotle," chipotle sauce sweetened with cola. Other iterations include maple with kimchi, corn with gochujang, and cayenne with Dubai chocolate.



Beekeeper's RTD Hot Honey Cold Brew Latte features Honduran coffee, aromatic chili, and ethically sourced Oregon honey; courtesy of Beekeeper.

Beverages Are On Fire

Consumers are adventurous. For spicy lovers, many seek spicy flavors in other applications. As discussed in Trendincite's March 2025 trend article[p], "3 Trends To Pay Attention To: Spicy Beverages, Experimental CPGs, and Camu Camu," spicy beverages are emerging. Beverages, both non-alcoholic and alcoholic, are innovating with interesting spicy flavor profiles. From soda to coffee, brands are experimenting. Mr. Pibb by The Coca-Cola Company has been reformulated and repackaged after nearly 25 years, with the new version rolling out this year. The beverage features 30% more caffeine and "a bold, spicy cherry taste with hints of caramel." It will be available in Mr. Pibb and Mr. Pibb Zero Sugar variants. Hot honey remains popular and has spilled into beverages. Mike's unveiled Hot Honey Syrup, optimized for hot and cold drinks. Mike's Hot Honey and AriZona Beverages collaborated on three hot honey-infused AriZona Tea flavors: Spicy Green Tea, Spicy Mucho Mango, and Spicy Watermelon. V8 Spicy Cajun joined V8's limited-edition spicy flavors lineup. Paris Hilton and International Delight teamed up on a Sweet & Spicy Creamer "that's hot and a mash-up of opposing flavors." Beekeeper Coffee and Gopuff partnered on the exclusive launch of Hot Honey Cold Brew Latte.



To meet rising consumer demand for bold, spicy flavors, Stoli unveiled Halapeño Pepper Vodka. It is the first Stoli vodka to be produced and bottled in Louisiana.

Alcoholic brands are also creating adventurous flavors. Bacardi's Global Brand Ambassador Survey[q] revealed that bartenders are leaning toward savory (26%) and spicy (24%) flavor profiles. To meet rising consumer demand for bold, spicy flavors, Stoli unveiled Halapeño Pepper Vodka. It is the first Stoli vodka to be produced and bottled in Louisiana.

Similarly, Absolut Vodka and Tabasco Brand partnered on Absolut Tabasco. It is made from the premium spirit with a natural essence derived from fermented, aged red pepper mash used in Tabasco sauce. South Korea's Ki One Whisky Distillery collaborated with Edward Lee, whisky writer and chef, on the limited-edition Ki One Red Pepper Cask. The single malt ages for three years in casks infused with Hong-Gochu red chili peppers. Inspired by hot dogs slathered in yellow mustard, James Gin

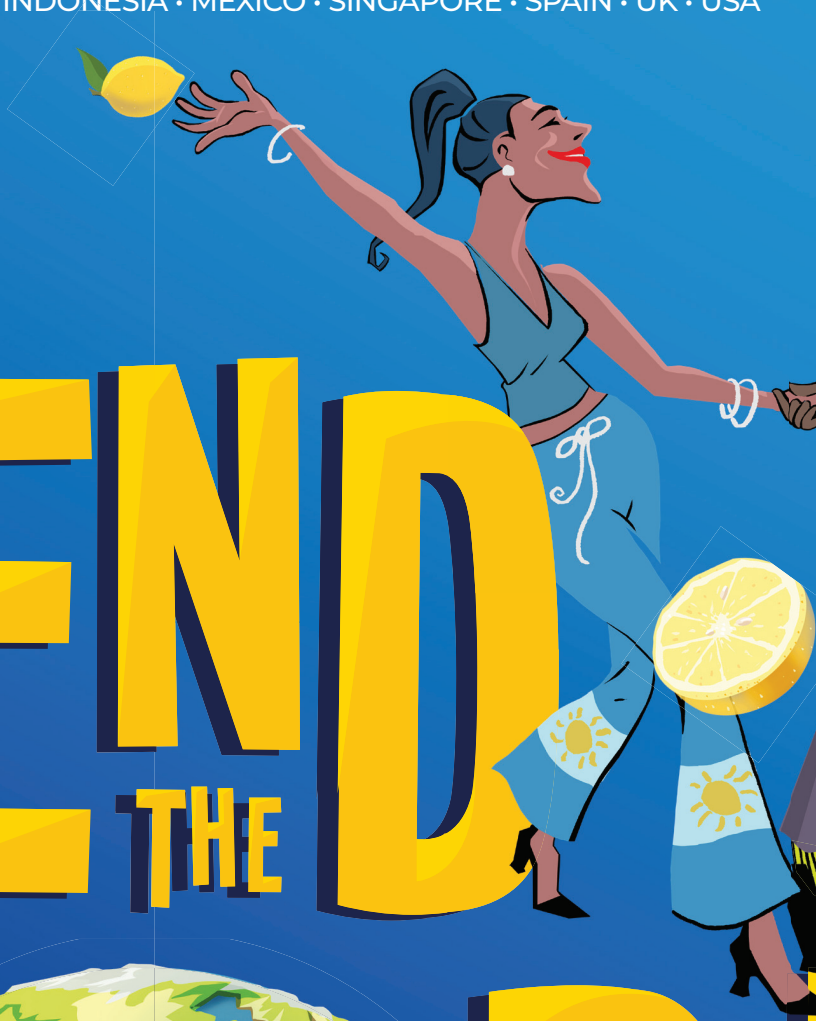
[o] *https://www.foodbusinessnews.net/articles/29469-culinary-trends-impacting-innovation-in-2026*

[p] *https://trendincite.com/3-trends-to-pay-attention-to-spicy-beverages-experimental-cpgs-and-camu-camu/*

[q] *https://www.bacardilimited.com/media/news-archive/connections-local-flavors-and-luxurious-experiences-top-the-2026-bacardi-cocktail-trends-report/*

Image courtesy of Beekeeper

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Rotten expanded its candy range with Spicy Sour Gummy Cruncheez, "that start off sour and then deliver a kick, all while keeping every bite interesting with tons of texture."

introduced American Mustard. The gin combines juniper, coriander, angelica root, orange peel, bay leaf, caraway, ginger, dried tomato, rosemary, cubeb pepper, licorice root, yellow mustard seed, and gherkin. In February, Beatbox rolled out Chillitas, a new line of four spicy-sweet flavored malt beverages: Chili Mango, Pica Piña, Sandia Loca, and Wild Paloma.

Candy Turns Up The Heat

Consumers' demand for spicy snacks is not waning, as addressed in Trendincite's *Perfumer & Flavorist*+[r] "Forward Thinking: Snacks Without Borders," which appeared in the September 2025 publication. Trendincite's *Perfumer & Flavorist*+ "Forward Thinking: Unwrapping Confectionery Trends" October 2025 article discussed how consumers crave new experiences, and candy is an ideal canvas for flavor experimentation. Spicy candy is the latest flavor profile to capture consumers' attention. According to Kerry[t], the swicy trend is evolving, with hot honey and spicy mango driving double-digit growth in bakery and confectionery products.

Mars was a pioneer in this territory, leaning into the swicy trend with the introduction of Skittles Gummies Fuego, which combines five fruit flavors–Lemon, Mango, Raspberry, Strawberry, and Watermelon with a chili-infused coating. Huer and Frank's RedHot collaborated on the Huer x Frank's RedHot Spicy Gummy Bears, which have been sprinkled with the Original Seasoning Blend. Inspired by Jumex drinks, Jumex has added GoMix gummies to its portfolio, made with real fruit juice. The candy is available in Original Mix and Spicy Original Mix, both of which highlight Guava, Mango, Peach, and Strawberry flavors, with the spicy version dusted in cayenne pepper. Jolly Rancher debuted Heat Wave Gummies featuring a chili-inspired coating in Mango, Pineapple, Watermelon, Lime, and Citrus Punch flavors, designed to "provide a warm, tingly, and fruity experience." Rotten expanded its candy range with Spicy Sour Gummy Cruncheez, "that start off sour and then deliver a kick, all while keeping every bite interesting with tons of texture." The gummies contain 58% less sugar than the leading brand and are formulated with allulose and glucose syrup, chicory root, monk fruit, cayenne, and ground pequin chili.

Bon Bon Bum x Tajín partnered on The Mix That Hits, a dippable watermelon and passion fruit-flavored lollipop with Tajín's chile-lime seasoning. The bubble-gum-filled lollipop includes a separate pouch of Tajín, letting consumers customize each dip. For Easter, Peeps introduced Chili Lime Mango Flavored Marshmallow Chicks, offering a swicy taste with mango, citrus, and a hint of chili heat, available exclusively at Kroger stores.

Dubbed the "ultimate umami crunch," Raaka and Momofuku have introduced a limited-batch Chili Chocolate Crunch bar. The unroasted dark chocolate bar highlights 54% cacao sourced from the Dominican Republic, infused with chilis, mushrooms, and garlic, with crispy puffed quinoa, pink sea salt, and sesame

[r]Page 26; *https://perfumerflavorist.texterity.com/perfumerflavorist/library/page/september_2025/*

[s]Page 16; *https://perfumerflavorist.texterity.com/perfumerflavorist/library/page/october_2025*

[t]*https://www.kerry.com/about/news-and-media/2026/kerry-launches-taste-charts-2026*

Image courtesy of Rotten

seeds for texture. Panda Express and Compartés have teamed up on a chocolate bar collection inspired by signature Panda Express dishes. The Kung Pao Bar is one of four flavors merging Panda Express' dried chili peppers, crunchy peanut bites, and flaky salt with rich dark chocolate. Not a candy, but a notable new limited-edition product is UK Kellogg's Crunchy Nut Hot Honey Crunchies cereal. The swicy cereal is formulated with "honey-coated golden curls infused with a gentle warmth from chili."

Fricy Is The Evolution Of Swicy

Swicy's rising popularity and staying power is unusually resilient due to its adaptability across various cuisines, according to Charlotte Myer, FreshDirect's SVP of Merchandising. Shannon O'Shields, VP of Marketing at Rubix Foods, believes there is a growing demand for "fruit-forward heat" tropical and citrus fruits like mango, guava, dragon fruit, pineapple, and yuzu, combined with the complex heat from jalapeno, habanero, and chipotle. She states, "Today's consumers, especially Gen Z, are gravitating toward flavor-building spices and chili varieties that bring character, not just burn." Similarly, "Fricy," a portmanteau of "fruity" and "spicy," was reported by the BBC[u] as a predicted food trend this year. Sous Chef, the online retailer, saw sales of Mexican Chamoy, a pickled fruit, lime, and chili combination, jump 64%, while Japanese Yuzu Kosho, a fermented blend of chili and citrus, grew 28%. Curtis Gong, Senior Product Development Scientist at Ocean Spray Ingredients, agrees, "Today's consumers want fruit plus something: heat, sour, botanical notes, or other layers that make familiar fruits feel new again. There is growing demand for flavors that are complex, tart, and highly versatile."

Sourness and citrus-driven acidity are increasingly being paired with spicy flavors. Koch Associates[v] predicts that sweet and spicy is evolving into Sweet, Spicy & Sour (The Next Swicy) with sour notes such as vinegar, tamarind, citrus, and sumac adding the pop. Likewise, Kitchen Hub[w] forecasts Swicy and Sour: Layered Flavors Rule, trending with the rise of sour flavors driven by yuzu, tamarind, calamansi, sumac, vinegar reductions, and fermented citrus.

Consumers love spicy food and beverages, particularly the younger generation. From sweet and salty to fruity to tangy and sour, creativity in spicy flavor pairing is limitless. There's no sign that this trend is waning. In fact, projections indicate that by 2029, 96.3% of menus will feature spicy food items, cementing spicy food trends as a permanent fixture in American dining, according to Datassential. Flavor suppliers and consumer packaged goods manufacturers will need to continue innovating to meet consumer demand for spicy flavors across multiple food and beverage applications.

Flavor & Product Innovation Takeaways

1. Move Beyond Simple Heat to "Layered Complexity"

Spicy flavor innovation is shifting from a focus on extreme heat to sophisticated, integrated experiences that enhance core flavors. Developers should focus on layering heat with other primary tastes—specifically smoky, acidic, tangy and earthy notes—to create depth rather than just a "burn". Trends like "swavory" (spicy + sweet + savory) and "swangy" (spicy + sweet + tangy) are emerging as the next wave of complex heat profiles.

2. Target "Fricy" and "Swicy" across New Categories

The portmanteau "fricy" (fruity + spicy) is a defining 2026 trend, driven by high demand for "fruit-forward heat" combinations like mango-habanero, pineapple-tamarind, and guava-cayenne. Beyond traditional snacks, these profiles are rapidly expanding into unexpected applications, including RTD beverages, coffee creamers, ice cream, and bakery fillings.

3. Leverage "Global Specificity" for Authenticity

Broad regional labels are being replaced by high-demand, locally specific spice sources. Chemists and developers should look to authentic ingredients like aji amarillo (Peruvian yellow chile), peri-peri (African bird's eye chili), gochujang (Korean fermented chili paste), and yuzu kosho (Japanese citrus-chili paste). This shift toward specificity meets the adventurous eater's desire for cultural connection and story-driven products.

4. Prioritize "Sourness and Acidity" as Heat Balancers

Acidity is increasingly used as a tool to brighten and pop heat profiles. Formulations are moving from simple "sweet + spicy" to "sweet + spicy + sour" mashups. Key acidic drivers for 2026 include tamarind, calamansi, sumac and fermented citrus, which provide the "tang" necessary for the emerging "swangy" trend.

5. Combat "Trend Fatigue" in Younger Demographics

Gen Z and younger millennials experience spicy food trend fatigue faster than previous generations, often migrating to newer variations as soon as a favorite goes mainstream. To remain competitive, brands must innovate quickly with limited-time offerings (LTOs) and bold mashups—such as "colapotle" (chipotle + cola) or hot honey-infused coffee—to maintain excitement and social media relevance.

[u] *https://www.bbc.co.uk/food/articles/2026_food_trends*
[v] *https://finance.yahoo.com/news/2026-flavor-trend-forecast-140000500.html*
[w] *https://www.trykitchenhub.com/post/flavor-trends-2026-textures-layers-and-new-menus*



To achieve greater impact, the industry must embrace a more ambitious and transparent trajectory, recognizing both its privilege and its duty to leave a legacy that inspires and uplifts future generations.

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Fragrances and Flavors at a Crossroads: From Fossils to the Future

Strengthening sustainability and resilience in a fossil-dominated industry.



Alain Frix founded Allchemix in 2020, as an independent consultancy focused on natural and synthetic ingredients for fragrances and flavors.

BY ALAIN FRIX

Although the global flavors and fragrances (F&F) industry represents a small fraction of global economic output, it plays a critical role in consumer perception, product differentiation and cultural expression. Beneath its creative image, the industry relies on a narrow and increasingly imbalanced set of feedstocks, dominated by fossil-derived petrochemicals. This article examines the historical evolution, current structure, and future trajectories of F&F feedstocks, integrating environmental, socioeconomic and geopolitical dimensions. By analyzing petrochemical dominance, the decline of natural ingredients, the geographic relocation of chemical production, and the limits of carbon-centric sustainability metrics, the article highlights systemic risks and identifies emerging building blocks for a more resilient and responsible F&F industry.

An Industry of Disproportionate Influence

The global F&F industry accounts for less than 0.04% of global GDP[1] and is valued at approximately $40 billion[2]. Despite its modest economic size, the industry exerts a disproportionate influence on everyday life. F&F ingredients shape sensory perception across food, personal care, household products and fine perfumery, deeply influencing consumer preference and brand identity.

This paradox—limited economic scale paired with significant cultural and sensory impact—makes the sustainability of the F&F industry particularly relevant. Sustainability claims are increasingly prominent. Yet, structural dependencies remain largely unchanged: petrochemical feedstocks dominate both volume and innovation pathways, while renewable and natural materials occupy a declining share.

Image by Petro at Adobe Stock; Courtesy of Alain Frix

Petrochemical feedstocks continue to dominate both volume and innovation pathways, while renewable and natural materials occupy a declining relative share. At the same time, the relocation of chemical production from Western countries to Asia has reduced operational costs and expanded access, but has also intensified environmental burdens and geopolitical dependencies.

This article explores how feedstocks shape the modern F&F industry, examining past dependencies, present imbalances, and the emerging building blocks that may define its future.

Feedstock Foundations of the F&F Industry

At its core, the F&F industry transforms raw materials into olfactory and gustatory experiences. Although perfumers and flavorists work with more than 3,000 commercial ingredients [3], these materials originate from a limited number of primary feedstock categories. Broadly, F&F ingredients derive from four main sources: petrochemicals, turpentine derivatives, essential oils and natural extracts, and a diverse group of other natural or emerging inputs (**F-1**).

Together, these feedstocks supply approximately 800,000 metric tons of aromatic materials annually, excluding solvents[3].

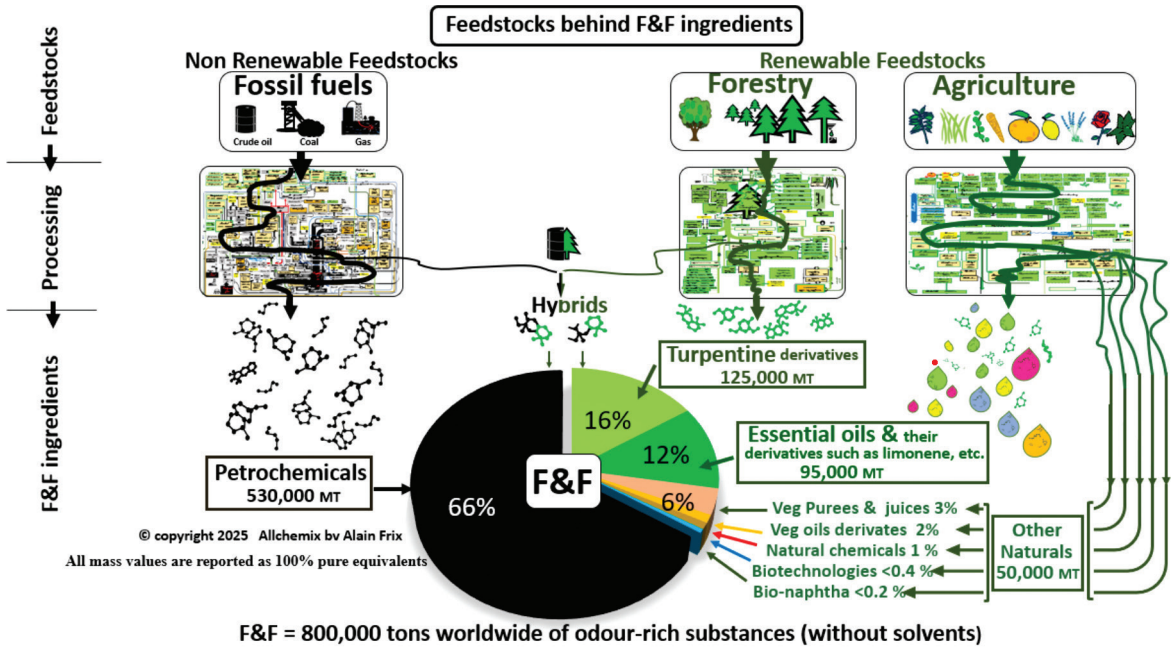
Petrochemicals dominate this volume, accounting for roughly 530,000 tons per year. Their prevalence reflects chemical versatility, reliable supply, and cost efficiency, enabling access to a broad spectrum of functional structures essential to modern fragrance and flavor creation.

Turpentine derivatives, contributing around 125,000 tons annually, originate from forestry by-products associated with cellulose and paper production. Although renewable in origin, these materials are extensively modified through chemical synthesis and are therefore classified as synthetic.

Essential oils and natural extracts, totaling approximately 95,000 tons per year, are sourced from more than 300 plant species and form the backbone of the industry's natural ingredient segment[3,4]. A final category of other natural ingredients includes fruit derivatives, botanical extracts and limited contributions from biotechnology.

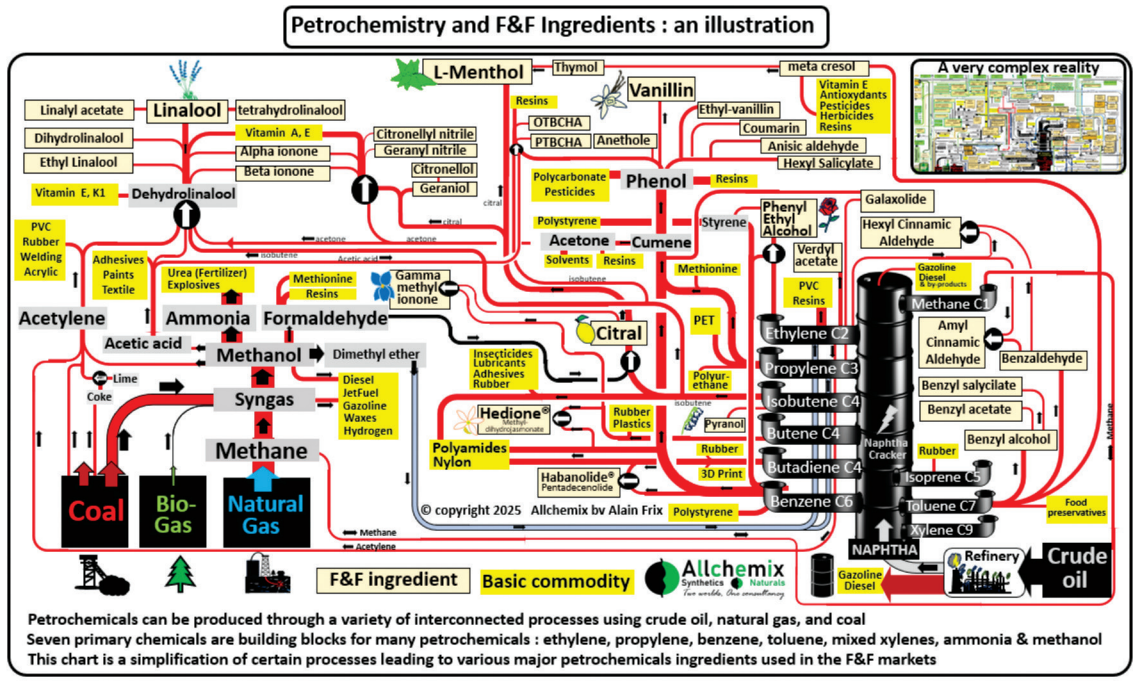
This distribution underscores a fundamental imbalance: while natural ingredients are central to industry narratives, fossil-derived materials remain structurally dominant.

F-1 **Broadly, F&F ingredients derive from four main sources: petrochemicals, turpentine derivatives, essential oils and natural extracts, and a diverse group of other natural or emerging inputs**



Courtesy of Alain Frix

F-2 **Petrochemical F&F ingredient supply chain outline**



Petrochemicals can be produced through a variety of interconnected processes using crude oil, natural gas, and coal
Seven primary chemicals are building blocks for many petrochemicals : ethylene, propylene, benzene, toluene, mixed xylenes, ammonia & methanol
This chart is a simplification of certain processes leading to various major petrochemicals ingredients used in the F&F markets

Source : Allchemix Consultancy

Petrochemicals as the Structural Backbone

Petrochemical derivatives account for more than 2,000 individual aromatic molecules used in the F&F industry[3,4]. All are derived from fossil fuels—crude oil, gas and coal—which still provide approximately 80% of global primary energy[5]. Contrary to expectations of rapid decarbonization, global fossil fuel consumption reached record levels in 2023, driven largely by demand growth in Asia[6], with petrochemicals expected to become the main driver of this demand in the long term[7,8] (**F-2**).

Petrochemicals benefit from mature, extreme complex global infrastructure, economies of scale and well-established synthesis pathways. Recycling generally remains limited, as recycled petrochemical intermediates are often more expensive than virgin materials derived from fossil sources[9,10].

From an industrial perspective, petrochemistry offers high predictability and cost stability—attributes that strongly influence ingredient selection in high-volume applications. While petrochemicals are sometimes treated as a monolithic category, there is an extreme variability in feedstock origin, energy mix and process efficiency, and one could even argue about high petrodiversity.

However, these advantages mask significant externalities. Fossil fuel extraction and processing involve land disruption, water contamination risks, air pollution and greenhouse gas (GHG) emissions that are not fully reflected in product-level sustainability metrics. Moreover, fossil resources are finite. At current consumption rates, crude oil reserves may be depleted within one century, a reality seldom integrated into long-term industry planning.

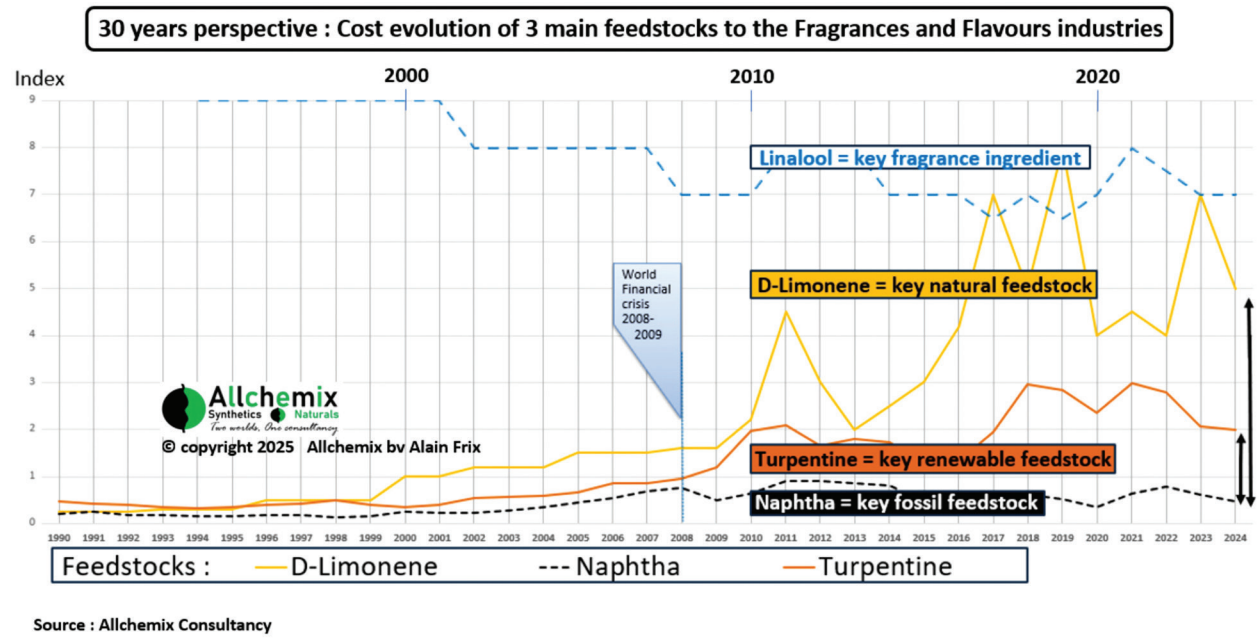
Economic Pressures and the Decline of Natural Ingredients

Natural ingredients play a unique role in the F&F industry, extending beyond their functional properties. Although global essential oil production is small compared with petrochemicals 4, natural ingredient supply chains have a unique socioeconomic impact, supporting millions of rural livelihoods and contributing significantly to local economies.

Over the past three decades, however, the price gap between natural feedstocks and petrochemical alternatives has widened considerably. Since the late 1990s—and particularly following the 2008 financial crisis—petrochemical intermediates have consistently

Courtesy of Alain Frix

F-3 The cost evolution of three F&F industry feedstocks



Source : Allchemix Consultancy

outperformed renewable alternatives in terms of price stability. This divergence has redirected investment toward fossil-based chemistry and accelerated the substitution of natural ingredients in cost-sensitive markets (**F-3**).

The case of L-menthol illustrates this shift.

L-menthol, prized for its cooling effect in oral care products such as toothpaste, exemplifies the shift from natural to petrochemical ingredients, driven primarily by price competition. Historically, L-menthol was extracted from *Mentha arvensis* oil (cornmint oil), whose global production exceeded 50,000 tons in 2013[11,12]. Mint cultivation, mostly in India, supports several million workers and is intercropped with staple food crops, providing critical diversification for farmers facing climate uncertainty[13].

Recent investments have significantly increased global production capacity for the petrochemical version of L-menthol. In 2022, Symrise AG and, separately, Shengyuan expanded their production of toluene-based L-menthol[14,15], while Zhejiang NHU Co. launched a citral-based version, another intermediate used for menthol[16]. In 2024, Wanhua Chemical Group inaugurated a citral plant in China with an annual capacity of 48,000 tons[17], while BASF AG plans to increase its production of citral to 118,000 tons this year[18]. This increase in petrochemical supply and its cheaper and more abundant precursors directly threatens the natural menthol market. In just two decades, the oral segment has shifted from a predominantly natural L-menthol to a predominance of fossil-derived L-menthol, bringing significant negative socioeconomic consequences.

Over the last three decades, while large F&F compounders have been consolidating at a fast pace, often incorporating family driven businesses into the stronghold of public rated companies, many F&F houses have been increasingly looking to replace dozens of sizeable renewable ingredients with petrochemical alternatives, purely driven by cost.

Delocalization of the Chemical Industry from the West to Asia: A Cost-Driven Shift

Since the 1990s, F&F ingredient production has gradually shifted from the West to Asia—primarily China and India—driven by a combination of cost considerations and regulatory pressures over past decades. Plant closures in Europe released skilled labor and equipment, which Asian investors effectively adopted and integrated, accelerating this transition. Stricter Western environmental regulations further encouraged outsourcing by companies seeking cost-effective compliance solutions, initially transferring their hazardous processes to Asia and later extending to broader manufacturing activities.

Today, following this cost-driven transition, Asia is a major global hub for chemicals, combining advanced technology, high production capacity, and a skilled workforce (**F-4**).

Courtesy of Alain Frix

In some perfumery materials, global dependence on Chinese petrochemistry exceeds 90%. Asia now leads not only in production but increasingly in innovation and is likely to drive future sustainable F&F solutions as it gradually transitions away from coal.

As illustrated by Ronald Piech in his historical account of fragrance chemistry in Germany[19], the modern fragrance industry has always been intrinsically linked to the chemicals sector. The ongoing relocation of global chemical production from West to East is moving the center of gravity for fragrance chemicals to Asia, significantly reshaping the global fragrance industry. Mirroring events in the textile industry, Asia is poised to become the world's leading producer of finished fragrances in the coming decades, in particular for personal care and household products.

Systemic Environmental Impact of Petrochemical Production Shifting to Asia

The relocation of F&F ingredient production to Asia has delivered undeniable economic benefits, but it has also reshaped the environmental profile of the industry in ways that are often underestimated. As compounders and consumer goods companies refine formulations and reduce ingredient costs, the upstream environmental burden of feedstock production has increased significantly.

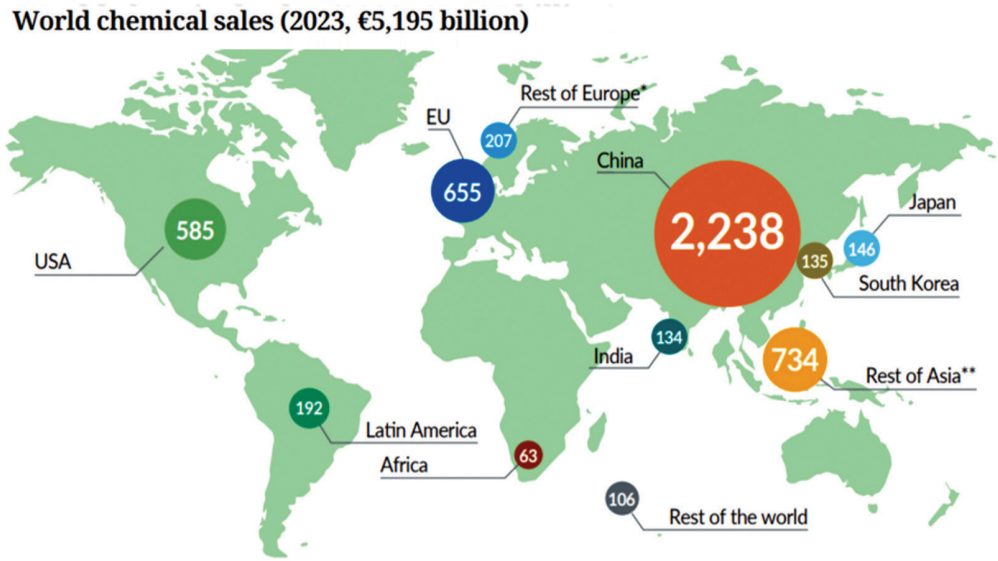
One of the primary drivers of this trend is energy. In many Asian countries—including China, India, Indonesia and Vietnam—chemical production continues to rely significantly on coal, which remains a major energy source. Although substantial investments in renewable energy are underway, electricity demand in the region is growing faster than clean energy deployment can currently meet[20,21].

Coal is both an energy source and chemical feedstock. In China, coal-to-chemicals pathways are central to methanol production, later converted into olefins like ethylene and propylene via methanol-to-olefins (MTO) technology. While technically efficient and strategically attractive in coal-rich regions, these processes generate substantially higher GHG emissions than steam cracking routes based on oil or natural gas, which remain dominant in Western countries[22,23]. Not all petrochemicals are created equal.

Transport further compounds the environmental burden. The majority of F&F ingredients produced in Asia are consumed in Europe and North America. Long-distance shipping adds a significant carbon penalty, particularly for bulky, high-volume aroma chemicals[24].

A structural paradox arises as F&F companies can reduce direct operational emissions (Scopes 1 and 2) by outsourcing production—predominantly to Asia—thereby increasing their upstream carbon footprint. Scope 3 emissions, in particular, also require careful

F-4 **Today, following this cost-driven transition, Asia is a major global hub for chemicals, combining advanced technology, high production capacity, and a skilled workforce**



Source : The Competitiveness of the European Chemical Industry, a joint study by Cefic - Advancy

Courtesy of Alain Frix

evaluation, as reported GHG reductions often rely on third-party claims that are not always readily auditable and, in some cases, on purchased carbon credits rather than actual GHG reductions in the supply chain. This can also occur with some mass-balance products, when they are physically entirely derived from conventional processes but reported as lower-carbon through carbon credit schemes.

Lifecycle Assessment and the Limits of Carbon Footprint metrics

Carbon footprint calculations have become the dominant sustainability indicator in the F&F industry. While useful, they capture only a fraction of total environmental impact. A comprehensive lifecycle assessment must consider resource extraction, processing, formulation, use and end-of-life degradation. (See sidebar: Behind the Green Curtain: Why Carbon Metrics Mask the F&F Industry's True Impact.)

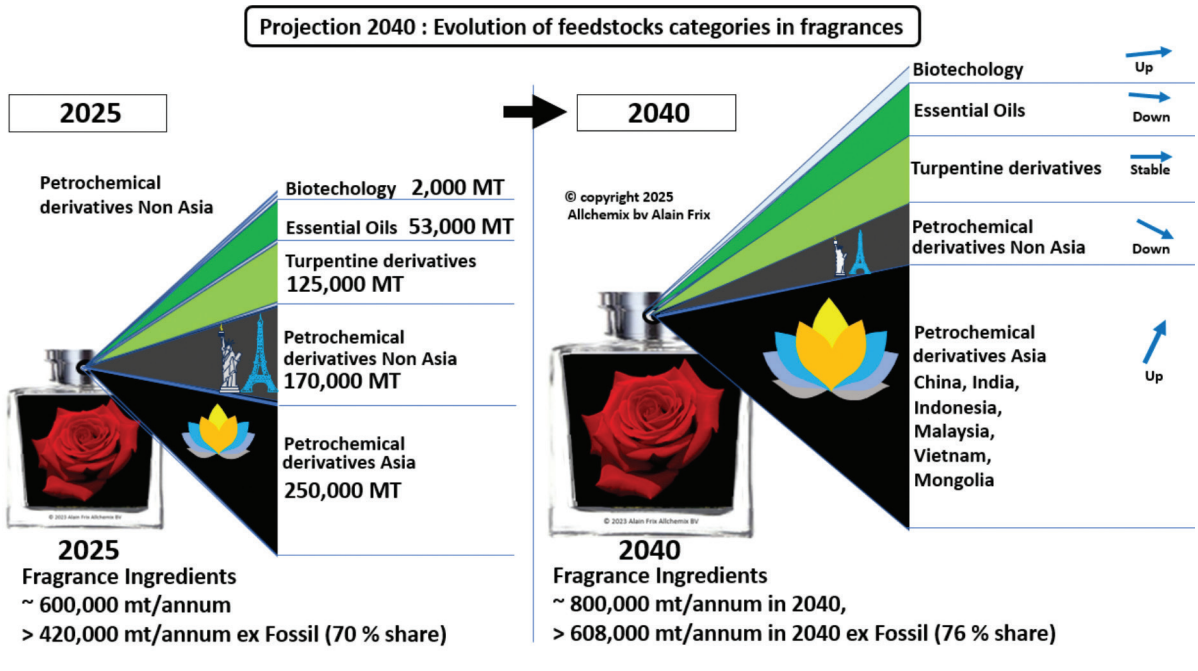
A simplified life cycle can be divided into eight major steps, each associated with distinct sustainability challenges. The most environmentally intensive stages are the first three, corresponding to the primary transformation of Earth's resources. For biomass, this includes

THE RISING SHARE OF PETROCHEMICALS: A 2040 PERSPECTIVE ON FRAGRANCE INGREDIENTS

Market projections indicate that the global demand for fragrance ingredients will continue to grow at an average annual rate of approximately 3% by volume through 2040. This growth, however, will not be evenly distributed across feedstock categories. Petrochemical-based ingredients are expected to grow significantly faster than natural alternatives, increasing their market share from around 70% today to nearly 76% by 2040 (**F-5**).

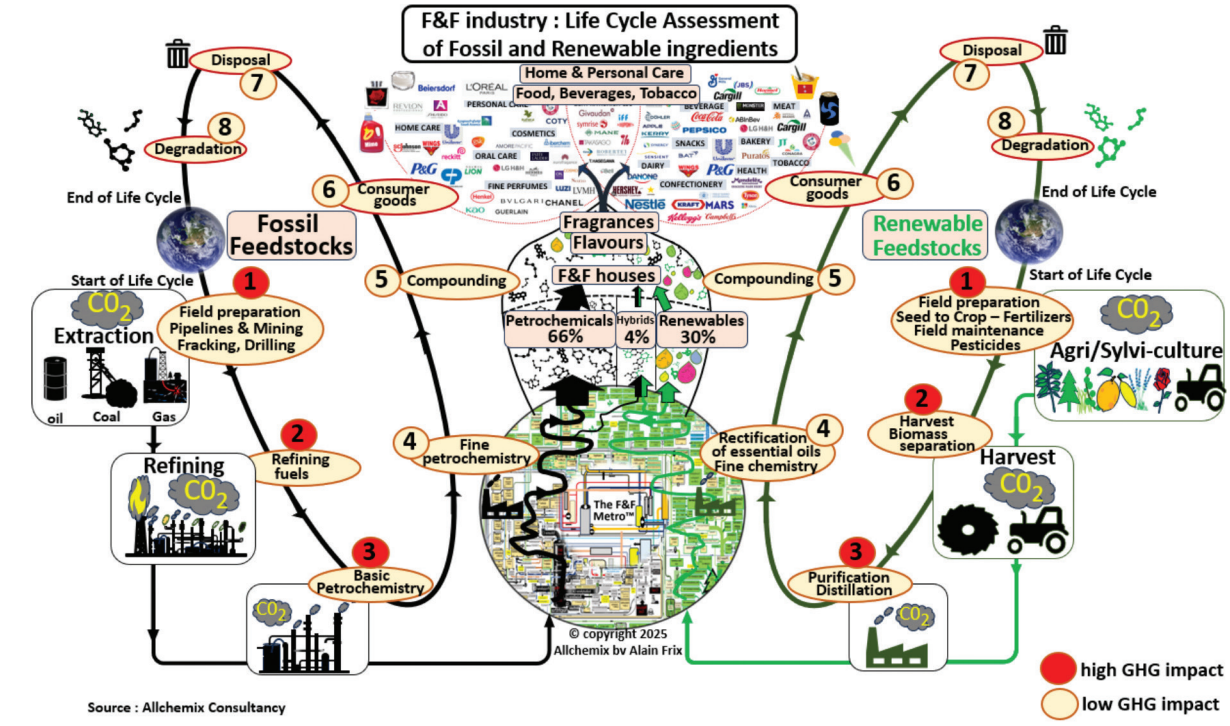
This trajectory reflects several reinforcing dynamics. First, cost sensitivity remains the dominant purchasing criterion in large-volume applications such as household products, personal care, and oral care. Second, standardization favors petrochemical ingredients with consistent quality and predictable supply. Third, regulatory pressure tends to focus on individual molecules, which can often be substituted within the broad portfolio of fossil-based chemicals.

F-5 Petrochemical-based ingredients are expected to grow significantly faster than natural alternatives, increasing their market share from around 70% today to nearly 76% by 2040



Courtesy of Alain Frix

F-6 Identification of the eight main stages in LCA of F&F products



land preparation, cultivation, harvesting and initial processing. For fossil resources, it involves land disturbance, drilling, extraction of fossil fuels, refining and heavy chemical transformation (**F-6**).

These stages are responsible for the majority of GHG emissions, water use, and ecological disruption. Methane leakage from coal and gas extraction sites alone accounts for hundreds of millions of tons of CO_2-equivalent emissions annually. Gas flaring increased by more than 5% in 2023, releasing emissions comparable to the United Kingdom's total annual emissions[31]. However, the extent to which these substantial fossil-related emissions are captured within petrochemical derivative audits remains highly unclear. According to UN estimates, farming contributes approximately 11% of global GHG emissions, while fossil fuel extraction and processing contribute around 10%[24].

Later stages of the lifecycle—fine chemistry, formulation and incorporation into finished products—generally have a much lower incremental environmental impact, particularly where green chemistry principles are applied. The author estimates that approximately 80% of the GHG emissions associated with the F&F industry originate from the production of F&F ingredients. By contrast, the core activity of F&F houses—blending these materials—requires relatively little energy. Consequently, the direct emissions of F&F houses (Scopes 1 and 2) are minimal and are rather the tip of the iceberg, when compared with the total lifecycle emissions of the sector, which are dominated by Scope 3 emissions.

End-of-life stages, including degradation and environmental persistence, remain complex and critical, especially for fragrance molecules released into wastewater systems.

Crucially, reliable LCAs require access to primary data from agricultural fields, mines, oil fields, refineries, and chemical plants. Without independent audits and transparent reporting, sustainability claims remain at best incomplete and at worst misleading.

Innovation Gaps and the Slow Emergence of Sustainable Design

While enjoying its creative reputation, the F&F industry has been relatively conservative in redesigning its molecular toolbox. Many high-volume ingredients in use today were developed more than 60 years ago and have changed little since. Regulatory restrictions in Europe are progressively limiting the use of large, persistent molecules, particularly in applications where they end up in wastewater.

One promising response is the development of high-impact "super-molecules" effective at ultra-low dosages. Ingredients such as Ambrostar (from Symrise), Z11 (from

Courtesy of Alain Frix

BEHIND THE GREEN CURTAIN: WHY CARBON METRICS MASK THE F&F INDUSTRY'S TRUE IMPACT

The widespread reliance on carbon footprint metrics has created what might sometimes act as a "green curtain." Products with favorable carbon scores may still generate significant toxic waste, water pollution or social harm. Conversely, some natural ingredients with low apparent carbon footprints may deliver substantial socio-economic benefits.

A clear example is catalyst-related toxic waste. Many F&F ingredients are produced through multi-step chemical processes that rely on catalysts, especially those derived from feedstocks like coal, natural gas, crude oil or turpentine. Despite growing adoption of green chemistry, heavy-metal catalysts are still used, generating toxic waste even when the reported carbon footprint is low. Therefore, when evaluating an ingredient's carbon footprint, its "catalyst footprint", reflecting catalyst use and associated waste, should also be considered, as it can substantially change the factual environmental impact. Especially when compared with essential oils which are produced via simple physical processes like distillation or expression without catalyst-driven reactions. Essential oils can have exceptionally low carbon and low catalyst footprint, such as citrus oils likely ranking among the highest sustainability performers within F&F ingredients, potentially surpassing biotechnological products, which sustainability scores also depend on the environmental footprint of their agronomical feedstocks (e.g sugar cane, rice bran, etc.). The author identified 16 indices directly related to product sustainability, out of 24 metrics defining a commercial product (**F-7**).

Vanillin provides a compelling illustration. Its 24-hour sustainability profile varies dramatically depending on origin: natural vanilla beans, lignin extraction, clove oil, ferulic acid fermentation, sugar-based fermentation, turmeric-derived routes, or petrochemical synthesis in Asia or in Europe. Treating all vanillin as equivalent based on a single metric obscures these differences and undermines informed decision-making. The absence of a standardized protocol for sustainability indicators in the F&F industry reflects a lack of sectoral desire for harmonization, highlighting the effort still required to move from partial transparency to true alignment. Yet, sustainability goes beyond products and the protocols that govern them; it also encompasses business practices. For instance, some F&F houses impose increasingly strict and prolonged credit terms on their suppliers, often as a way to pass on the financial credit requirements they themselves receive from their customers, sometimes with the implicit expectation that maintaining the business relationship depends on accepting these conditions. While these practices are not inherent to the products themselves, companies should also be assessed based on the financial pressures they exert on their broader socio-economic environment, an aspect that is undeniably a significant component of sustainability. Other examples include the gradual upward transfer of supply chain risks to the more upstream vulnerable suppliers within the value chain.

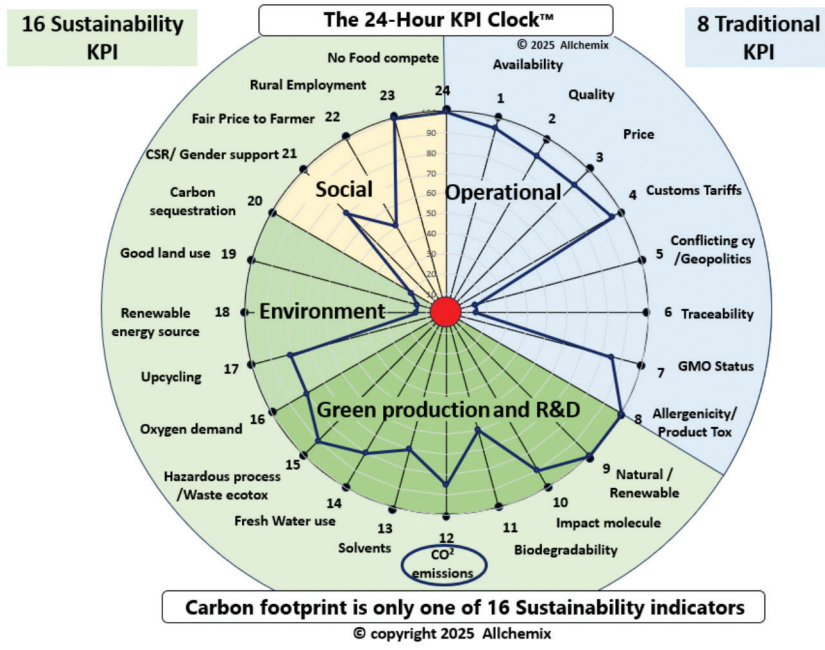
MAPPING DEPENDENCIES: THE F&F METRO

The world of F&F ingredients can be compared to a vast subway system, where each station represents a chemical and individuals are the compounds themselves. Mapping the connections between these "stations" is essential to understanding the dependencies within material flow chains. Only by doing so can we begin to accurately assess the sustainability profile of a specific ingredient.

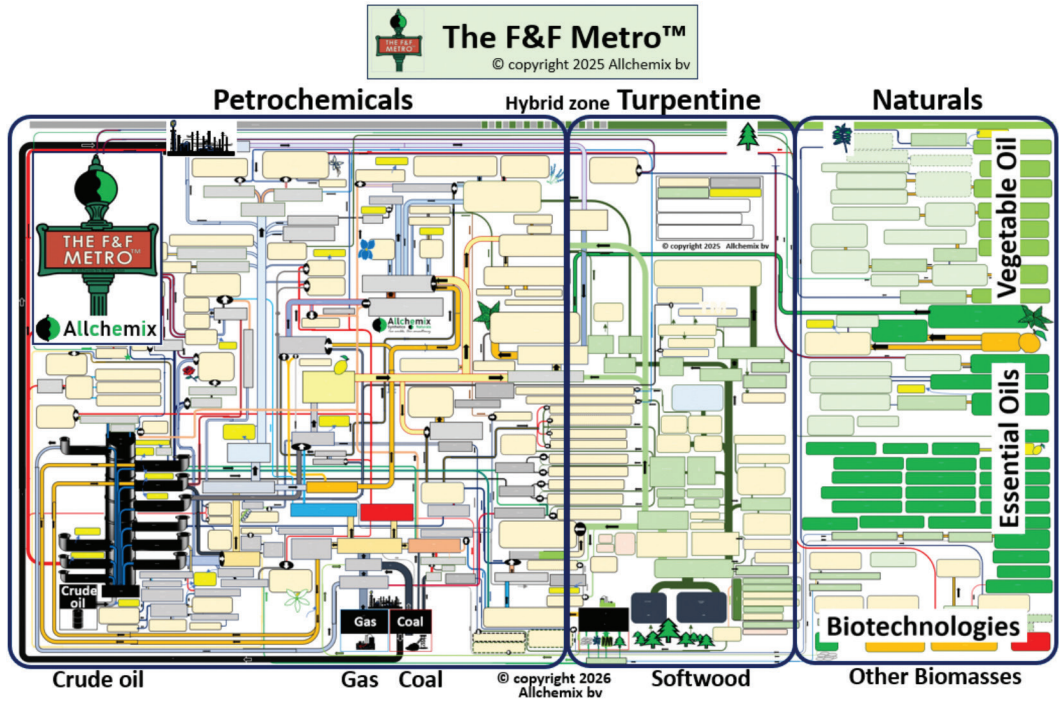
There are often multiple routes to reach the same destination, which adds another layer of complexity to the system. To illustrate this, the chart below shows the practical interactions between different feedstocks and some of the many F&F ingredients. While the visual may appear complex, each pathway—represented by a tube—reflects a series of transformation steps that can increase significantly in complexity, sometimes by a factor of 10.

At this stage, it becomes possible to assess whether the transformation steps involve eco-toxic catalysts, halogenation reactions or other environmentally harsh processes—even when the overall carbon footprint appears low. There's significant variation in the nature of these chemical transformations, particularly in processes linked to petrochemical and turpentine-derived pathways. This contrasts with the generally greener production of essential oils, which rely mainly on distillation rather than extensive chemical modification and molecular assembly (**F-8**).

F-7 **The author identified 16 indices directly related to product sustainability, out of 24 metrics defining a commercial product**



F-8 **Interconnecting feedstocks and F&F ingredients**



Source : Allchemix Consultancy

Courtesy of Alain Frix

dsm-firmenich) or Pomarose (from Givaudan) exemplify this approach. By reducing required volumes, these materials lower the energy needed to manufacture them, cut transportation emissions and minimize waste generation—delivering benefits across multiple dimensions.

However, despite their advantages, these molecules are often more expensive than their larger petrochemical counterparts[25], and they also frequently require a high level of perfumer expertise to use them effectively. Even today, young perfumers are taught to create fragrances using large, conventional petrochemical commodities. This may stem from the fact that, for many decades, major F&F companies operated as primary producers of a wide range of sizeable petrochemical ingredients before eventually shifting their manufacturing operations to external suppliers in Asia.

Some of the large chemicals used in F&F date back more than 100 years and have changed little in that time. Unlike electronics, which have miniaturized products, the F&F industry still relies on massive, energy-intensive chemicals. This is not due to lack of talent, but rather a status quo approach where sustainability competes with other drivers. For agile companies, regulatory constraints—often initially perceived as an obstacle—can become a strategic lever, boosting creativity, strengthening differentiation, and fostering the emergence of responsible models. Rather than hindering progress, regulatory constraints often penalize a lack of anticipation[26], and promote close collaboration between regulators, decision-makers, researchers and industrialists.

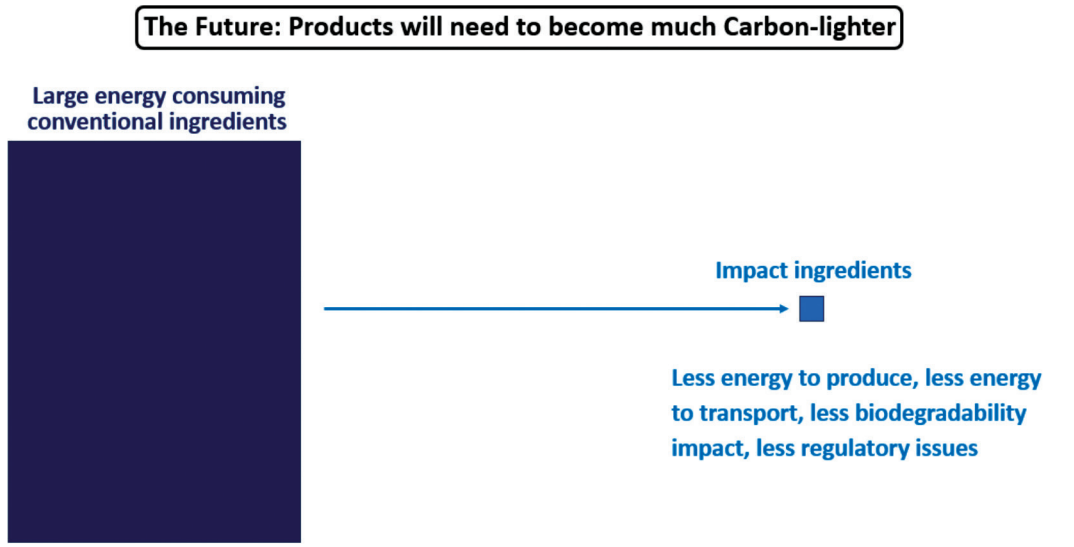
The Biodegradability Paradox

Biodegradability has become a key selection criterion for fragrance ingredients, yet it is frequently misunderstood. Standard biodegradability tests are conducted under ideal laboratory conditions that rarely reflect real-world environments. Passing such tests does not guarantee rapid or complete degradation in natural ecosystems.

Some molecules fragment into smaller compounds without full mineralization, potentially generating persistent micro-pollutants[27,28]. Paradoxically, the use of very small quantities of low-biodegradability materials may, in certain cases, be environmentally preferable to the large-scale use of partially biodegradable ones.

The key question is how to shift from producing 500,000 tons of conventional carbon-based aroma chemicals to just 10,000 tons of highly impactful molecules (**F-9**). Developing ultra-low-dose, high-impact fragrance

F-9 **The key question is how to shift from producing 500,000 tons of conventional carbon-based aroma chemicals to just 10,000 tons of highly impactful molecules**



Courtesy of Alain Frix

COMMON SENSE AT A CROSSROADS: RECLAIMING ETHICS AND INDUSTRIAL LOGIC IN F&F

The F&F industry is increasingly constrained by regulatory uncertainty—at times amplified by decisions developed in isolation at government or regulatory hubs—and by a fragmented industrial landscape. Many consumer goods companies and compounders face rising financial pressures and may overlook supplier continuity, weakening the resilience of the entire ecosystem.

There is broad consensus on the need for sound regulatory and industrial frameworks that promote safer consumption and reduce environmental impact. Progress requires aligning industry and regulators around practical, sustainable solutions guided by common sense—the ability to balance long-term objectives with pragmatic action.

The importance of this principle was remarkably highlighted by Jean Mane in his inspiring address at IFEAT Göteborg on September 16, 2025, emphasizing the resilience needed to preserve common sense amid regulatory and industrial turbulence[29]. Similarly, in his presentation "Will All the Flowers Be Gone?" at IFEAT Dubai on September 27, 2016, Kim Bleimann stressed the need to protect the natural reservoirs of essential oils that have sustained human well-being for millennia—an example of scientifically informed common sense rooted in both tradition and evidence-based reasoning[30].

The F&F industry faces significant strategic challenges driven by leadership imbalances, short-term financial pressures and risk-averse cultures that prioritize stock-market performance over industrial resilience.

While some mergers and acquisitions genuinely create value, many are largely cosmetic, enhancing perceived performance rather than building lasting strength. Frequent mergers—and increasingly, demergers —combined with cost-cutting initiatives and workforce reductions, often result in the loss of critical active expertise, the very foundation of mid- and long-term value.

M&A can, at times, resemble a high-stakes environment, where misjudged timing or pricing can have long-lasting consequences and erode decades of legacy. Leadership in this environment is rather ephemeral, replaced by sophisticated but often inexperienced teams, while functional hierarchies give way to rigid, bureaucratic structures. Encouragingly, not all companies follow this path; the most resilient adopt alternative approaches grounded in common sense and long-term industrial logic.

In the drive to cut costs, some companies compromise on quality, particularly with so-called natural flavor ingredients in the food chain. Genuine natural components are sometimes substituted with ultra-low-cost, certification-only materials from regions with unreliable audits, potentially misleading consumers on the naturality of what they eat. Short-term managerial pressures can stretch ethical boundaries, making rigorous due diligence and robust governance essential, particularly for natural flavor ingredients. Ethical procurement practices face intense pressure from financial management, as a result ethics is prone to gradual erosion. Despite extensive corporate reporting, a new short-term industrial reality has emerged, shaped by shareholder expectations.

This raises the important question of whether the industry can really continue to self-regulate its ethical standards as effectively as it did a decade ago.

Restoring common sense in management, grounded in ethics, empirical knowledge, professional experience, and long-term value creation, could be the most impactful and urgently needed investment for the F&F industry. By taking this approach, both industry leaders and regulators can reconcile ambition with prudence and performance with sustainable purpose, pursuing growth responsibly while delivering lasting value.

ingredients open new sustainable pathways, as their high unit value makes production from renewable biomass economically attractive and competitive.

This represents the only viable path to establish a long-term program for gradually replacing petrochemicals. While they currently drive both quality and cost efficiency, their finite nature of fossil derivatives will compel the F&F industry to accelerate the transition toward lower-carbon, preferably renewable, impactful solutions.

The Biomass Barrier: Why Biobased Molecules Struggle to Outrun the Fossil Legacy

Fossil fuels are hydrocarbons formed from ancient biomass over millions of years under intense underground heat and pressure, at virtually no cost. In contrast, producing comparable hydrocarbons from fresh biomass using current technologies remains both inefficient and expensive.

Forest biomass—the most abundant on Earth—consisting primarily of cellulose, hemicellulose and lignin, is difficult to break down into usable molecules. While emerging technologies such as supercritical hydrothermal liquefaction (HTL), microbial depolymerization and synthetic biology offer promising prospects, it may be several decades before biobased polymers can really compete in mass markets.

Despite major biotech investments in the F&F industry, in aerobic fermentation in particular, only a few biobased molecules have achieved commercial success, representing less than 0.4% of the market by volume. Efforts to replace petrochemicals involve drastically cutting production costs—a challenge that has so far failed for biotechnologies.

While advances in anaerobic fermentation and microbial strain control are promising, scaling them up requires significant investment. If successful, these technologies could benefit agriculture by improving soil health, as well as directly capturing certain GHG and converting them into fuels, chemicals or proteins with lower net emissions than fossil-based methods[30-34].

Although environmental regulatory uncertainty and geopolitical tensions may tempt some companies to delay investments in decarbonization technologies, an increased focus on R&D of biomass-driven solutions remains fundamental, as the increasing scarcity of fossil fuels by the end of this century will pose a major challenge.

Given that biomass will become the last remaining carbon supplier once fossil fuels become scarce, agricultural sectors and rural communities are set to play a key role in addressing current and future challenges.

In Conclusion: A Call to Action

While F&F sector companies have limited influence over raw material extraction practices, they bear full responsibility for their sourcing choices and must accurately assess the actual sustainability of their raw materials and derivatives. To enhance sustainability and reduce our dependency from finite resources, the industry must:

- Implement rigorous lifecycle assessments (LCAs) based on primary and secondary data, for petrochemical and biomass supply chains, to identify products with a lower environmental impact.
- Increase investments in raw material diversification, supporting the development of biomass conversion technologies, synthetic biology and other biobased technologies.
- Promote their R&D investments in biomass-derived ingredients both by distinguishing them from those dedicated to fossil ingredients and by reporting them separately.
- Prioritize high-impact, low-volume solutions that reduce the consumption of raw materials, energy and environmental waste throughout the value chain.
- Partner consumer goods companies in encouraging responsible consumption and the design of lighter, more sustainable products that offer equal or superior quality, as already seen in the electronics sector.
- Foster collaboration between all stakeholders—researchers, regulators and manufacturers—to create innovation ecosystems with a clear, predictable trajectory towards more sustainable products.

A DUTY TO SHAPE A BETTER LEGACY: REDESIGNING THE WEIGHT OF THE F&F INDUSTRY

Adapting processes and strategies towards increased sustainability has the merit to rethink the most adequate way to manufacture a viable product considering changing future supply chains and consumers[31-36].

A foundational principle of sustainability is that reduced consumption often brings the highest environmental benefit. And, ultimately, the most sustainable product is the one we choose not to consume.

Over the coming years, it will be vital for the industry to design smaller-volume, high-quality consumer goods with a significantly lighter carbon footprint, while consumer goods companies work to gradually shift consumer attitudes and educate future generations to embrace lower, more socially responsible consumption patterns. Without bold innovation and profound systemic transformation, the F&F sector risks exacerbating its environmental footprint and undermining its long-term sustainability.

Implementing low-carbon F&F solutions will significantly enhance the sustainability profile, reducing the impact of energy used in both production and transportation.

The industry carries the privilege, and the duty, to leave a better legacy that inspires and uplifts the next generations.

F&F Sustainability Dashboard: A Stepwise Approach

Many corporate sustainability reports rely on extensive datasets, complex metrics and success stories to communicate progress. While initiatives that reduce Scope 1 and 2 emissions—such as installing solar panels at compounding sites—are positive, they address only a limited share of the total environmental footprint. The dominant impact resides upstream, within Scope 3 supply chain activities, particularly ingredient production.

Energy consumption, water use, toxic waste generation, and soil depletion associated with fossil and renewable ingredient manufacturing are generally much higher than the impacts of compounding operations.

To commonly track performance and enable improvement, a focused and comparable sustainability dashboard is required, built on simple yet robust and auditable metrics.

Coverage of Ingredients

All F&F ingredients should be assessed, with exclusions limited to cases where meaningful comparison is not possible. Exclusions should include:

- Solvents present in the finished perfumes and flavors should be excluded from primary calculations and reported separately, as their disproportionate volume relative to F&F aroma materials can skew results and enable manipulation. While they are important adjuvants without intrinsic odor, their levels can be adjusted to artificially improve a compound's sustainability profile, masking the true performance of the fragrance composition itself.
- Ingredients containing more than 50% water (e.g., juices), for the same distortion risk; should be excluded and reported separately.
- Products linked to carbon credit schemes—such as many mass-balance offerings—where operations remain unchanged and reported sustainability gains come mainly from offsets, should be excluded from core performance metrics and reported separately. For example, a compounder might increase the use of carbon-intensive, coal-derived feedstocks and rely on carbon credits to improve reported sustainability. While this may enhance metrics on paper, it does not represent a true reduction in the product's environmental footprint and can mask unsustainable practices. Sustainability reporting should focus on real progress—past and future—and be fully transparent about the role of carbon credits, ensuring that reported improvements reflect genuine environmental impact.
- Hybrid products: For ingredients synthesized from both petrochemical and renewable feedstocks, reported volumes should be allocated in proportion to the fossil versus renewable share of the reaction mass.

Core Metrics

Core metrics (CM) should be developed separately for fragrance compositions and flavor formulations, as their product portfolios differ substantially. In many respects—including feedstock profiles—flavors and fragrances operate as distinct industries. For example, the flavor sector relies less on fossil-based inputs than the fragrance sector, as it incorporates a higher proportion of agricultural ingredients such as fruit juices and vegetable purées. Since CM are intended to enable meaningful performance benchmarking, comparisons must be made within homogeneous categories—comparing like with like, at least as an initial approach.

CM 1: General Indicator: Share of fossil-derived versus renewable finished ingredients by volume used for internal compounding.

This should be followed by eight indicators calculated on the basis of the average performance of the highest-volume ingredients used in the company's compounds, covering 75% of the total volume within each ingredient category (fossil and renewable).

CM2: Average carbon footprint of largest fossil-derived ingredients.

CM3: Average water footprint of largest fossil-derived ingredients.

CM4: Average hazardous waste of largest fossil-derived ingredients.

CM5: ESG quantification: share of fossil-derived ingredients supporting rural employment and certified by ESG-oriented programs.

CM6: Average carbon footprint of largest renewable ingredients.

CM7: Average water footprint of largest renewable ingredients.

CM8: Average hazardous waste of largest renewable ingredients.

CM9: ESG quantification: share of renewable ingredients supporting rural employment and certified by ESG-oriented programs.

Measurement protocols to be applied:

Carbon footprint: ISO 14067, expressed as kg CO_2-equivalent per kg of finished ingredient.

Water footprint: ISO 14046, expressed as m^3 of water per kg of finished ingredient.

Hazardous waste: Defined under applicable regulatory classifications (e.g., U.S., EU) and reported per kg of finished ingredient produced. This includes solid, liquid, or semi-liquid materials deemed hazardous, such as process residues, solvents, sludges, and spent catalysts.

ESG quantification: For fossil-derived ingredients, report each volume share verified by independent auditors such as SGS, Bureau Veritas, DNV, Intertek, TÜV, LRQA, along with the share of ingredients covered by internal ESG audits and on-site inspections of petrochemical and fossil fuel facilities by own specialized teams. For example, 10% of petrochemical ingredients are SGS-verified, and 20% are audited on-site by our specialized teams, with full reporting publicly available indicating the socioeconomic impact. For renewable ingredients, report each volume share verified by independent auditing organizations such as Fair Trade, Rainforest Alliance, UEBT, PEFC, FSC, as well as the share of ingredients subject to internal on-site ESG assessments conducted by own specialized agronomical teams, as has been standard practice. Robust internal audits, grounded in decades of industry experience, should take precedence over external certifications, which may at times rely on less experienced auditors. However, many F&F companies reduce internal oversight for cost reasons and delegate this responsibility to third parties, allowing certification labels to outweigh on-the-ground realities. For example, 10% of renewable ingredients are UEBT-certified, and 20% are audited on-site by our specialized teams, with full reporting publicly available indicating the socioeconomic impact.

Tracked year by year, these nine indicators provide a clear view of each F&F house and, collectively, highlight the industry's sustainability trajectory, provided that ingredient-level data are based on verified LCA datasets, supplier disclosures, or third-party reviewed estimates.

As discussed earlier in the article, many additional sustainability indicators could be considered. However, the CM1–CM9 dashboard already provides stakeholders—compounders, consumer goods companies, regulators and investors—with a clear and practical starting point to monitor progress, identify priorities and drive improvements across the F&F value chain.

Meaningful progress in the F&F industry requires clear, consistent and comparable measurement. To achieve greater impact, the industry must embrace a more ambitious and transparent trajectory, recognizing both its privilege and its duty to leave a legacy that inspires and uplifts future generations.

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About the Author

Alain Frix founded Allchemix (*www.allchemix.com*) in 2020, as an independent consultancy focused on natural and synthetic ingredients for fragrances and flavors. Based in Belgium, Frix brings 35-plus years of industry experience, advising leading F&F compounders, luxury brands, consumer goods companies, investors and ingredient producers worldwide.

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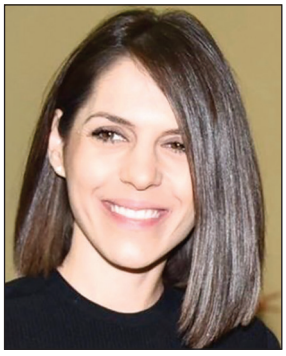




The woody, earthy elements of distilled West Indian lime oil make it essential addition to cola flavor profiles, whereas its floral and resinous character would benefit stone and tropical fruits flavors.

Savory to Zesty: An Organoleptic Deep Dive into EU Natural Flavor Ingredients

Our April 2026 Flavor Reports, EU Edition, features massoia lactone, cassia oil, styrallyl acetate and much more.



BY MARIA PALASSAROU
Flavorist, Givaudan

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Image courtesy of Jacob Lund

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For flavor chemists constantly on the hunt for the next essential building block, this month's column, authored by flavorist Maria Palassarou, is your high-impact download. We're diving deep into the performance of EU natural aromatic ingredients from De Monchy Aromatics, critically assessed by our elite organoleptic panel. Inside, you'll find the technical and sensory breakdowns of a powerful lineup—from the creamy brown notes of furanone and the savory complexity of sulfurol, to a unique, natural vanillin and the zesty, floral profile of distilled West Indian lime. Prepare to rethink your naturals palette with data-driven insights that will elevate your next formulation. -Editor



At 15 ppm, 2,5-dimethyl-4-hydroxy-3(2H) furanone evokes notes of cooked pineapple and strawberry, among others.

About the Ingredients Featured

In this month's column, we evaluate ingredients from De Monchy Aromatics—founded in 1959—a specialist in EU-natural aromatic ingredients, with production taking place in China, Bulgaria and the United Kingdom.

2,5-Dimethyl-4-Hydroxy-3(2H) Furanone

FEMA# 3174, CAS# 3658-77-3

- **Characteristics:** A furan with molecular formula C6H8O3, found in nature, also known as furaneol, strawberry furanone, pineapple ketone.
- **Odor Descriptors @ 1%:** Caramel, sweet, cotton candy, burnt sugar, brown notes, bready, butter notes, slight creamy, sharp, ripe fruit notes, fruity strawberry.
- **Taste Descriptors @ 15 ppm:** Caramel, sweet, brown notes, cotton candy, burnt sugar, bready, fruity, honey notes, buttery, cooked pineapple, strawberry notes, creamy.
- **Possible applications:** Its sweet caramel element would complement all brown tonalities characteristic of rich, warm, indulgent notes, such as toffee, maple, and chocolate, whereas it would provide additional complexity to nutty profiles, such as pecan and coffee flavors. The dominant candy fruity aspect would make it a great addition to various sweet fruit tonalities, like strawberry, pineapple and mango. Its burnt sugar impression would complement, apart from cotton candy, or syrup tonalities, also savory profiles, like BBQ sauce flavors, where the sweet note would provide complexity.

4-Methyl-5-Hydroxy Ethyl Thiazole

FEMA# 3204, CAS# 137-00-8.

- **Characteristics:** A thiazole with molecular formula C6H9NOS, found in nature, also known as sulfurol.
- **Odor Descriptors @ 100%:** Cooked, boiled, eggy, condensed milk notes, sulfur, milky, creamy, custard notes, nutty, beany, savory notes, meaty.
- **Taste Descriptors @ 10 ppm:** Cooked, eggy, condensed milk notes, boiled, meaty, brothy, savory chicken, yeasty, bready, sulfur notes, burnt caramel, creamy, beany.
- **Possible applications:** Its intense cooked, milky, eggy character would complement all dairy tonalities, such as condensed milk, cream, yogurt, cheese, whereas it would provide additional complexity to milk-based cooked desserts, like custard and pudding. The nutty element in combination with the sulfur notes would make it a great addition to chocolate flavors, but also nut profiles. Moreover, its meaty, brothy character would provide complexity to various savory tonalities, such as chicken and beef.

Massoia Lactone, EU Natural

FEMA# 3744, CAS# 54814-64-1.

- **Characteristics:** An alkyl lactone with molecular formula C10H16O2, found in nature, also known as 5-hydroxy-2-decenoic acid, (6R)-6-pentyl-5,6-dihydropyran-2-one, 5-hydroxy-2-decenoic acid delta-lactone.
- **Odor Descriptors @ 100%:** Lactonic, coconut, creamy, milky, waxy, sweet, fruity, peach notes, slight burnt, tonka hay, woody, caramel note.

Image by R Studio at Adobe Stock

- **Taste Descriptors @ 2 ppm:** Lactonic, coconut, sweet, creamy, milky, tonka, hay, burnt notes, waxy, woody, fruity peach, caramel, vanilla.
- **Possible applications:** Its characteristic lactonic, creamy, waxy aspect would complement, besides coconut flavors, all dairy tonalities, like cream, and vanilla profiles, such as French vanilla. The additional sweet caramel element would make it a great addition to all brown flavors, like caramel, toffee, and chocolate profiles, providing an indulgent note. The fruity, creamy character would complement all stone fruits profiles, like peach and apricot, whereas its tonka, burnt element would benefit all spirit tonalities, such as whisky.

Vanillin EU Natural (ex-Ferulic Acid)

FEMA# 3107, CAS# 121-33-5.

- **Characteristics:** A phenolic aldehyde with molecular formula C8H8O3, found in nature, known as 4-hydroxy-3-methoxybenzaldehyde.
- **Odor Descriptors @ 1%:** Vanilla, powdery, sweet, creamy, milky, slight phenolic, balsamic, tonka hay notes, anisic, slight brown, buttery, woody.
- **Taste Descriptors @ 25 ppm:** Vanilla, sweet, creamy, milky, powdery, phenolic, balsamic, woody, slight buttery, brown notes, anisic.
- **Possible applications:** Its intense sweet, creamy, powdery character would complement almost all flavor tonalities, in addition to vanilla flavors. Its characteristic milky, creamy, buttery notes would make it a great addition to all brown indulgent profiles, like caramel, butterscotch, chocolate, but also sweet dairy tonalities, like cream. Moreover, its sweet, creamy element would provide complexity to stone fruit profiles, like peach and apricot, but also in all candy fruit tonalities, like strawberry.



Cassia oil redistilled has an odor profile that is sweet, warm, spicy, woody, powdery, earthy, resinous and dry.

Cassia Oil Redistilled

FEMA# 2258, CAS# 84961-46-6.

- **Botanical Name:** *Cinnamomum cassia* Blume .
- **Characteristics:** The cinnamon oil from China is known as "cassia oil," which is a slightly different variety from the Indian or Sri Lankan types, which are traded as "cinnamon oils." The leaves and branches are distilled across all origins, but whilst the bark is used in Sri Lanka, it is rarely used in China.
- **Odor Descriptors @ 100%:** Cinnamyl, sweet, warm, spicy, woody, powdery, earthy, resinous, dry.
- **Taste Descriptors @ 5 ppm:** Warm, cinnamyl, sweet, spicy, woody, powdery, dry, musty, earthy, hay notes, clove, slight coumarinic.
- **Possible applications:** Its dominant sweet, cinnamyl, spicy notes would complement, besides cinnamon or cassia profiles, all spice blends tonalities, like chai, bunspice, gingerbread and speculoos, whereas it would also provide complexity to Cola profiles. The characteristic warm, woody, coumarinic elements would make it a great addition to beany vanilla profiles, like Madagascan Bourbon vanilla, cherry flavors, but also spirit tonalities, like rum, where a spicy tingling note is needed.

Lime Oil Distilled West Indian Type

FEMA# 2632, CAS# 90063-52-8.

- **Botanical Name:** *Citrus aurantifolia* (Christman) Swingle.
- **Characteristics:** The screw-pressing of the fruit produces a juice-essential oil emulsion. After the juice is largely separated from the settled oil layer, still steam-distillation of the remaining juice-oil emulsion takes place. This results in changes to the essential oil that are similar to the changes induced by thermal treatment in highly acidic conditions.
- **Odor Descriptors @ 100%:** Woody, terpenic, lime, floral, zesty, sweet, citrus peel, dry, earthy, camphoraceous, resinous.
- **Taste Descriptors @ 20 ppm:** Woody, earthy, lime, terpenic, citrus peel, floral, citrusy lemon, sweet, warm, zesty, resinous.

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At 100%, orange oil West Indian type wild sweet has sweet orange, juicy, fresh, ethereal, terpenic, aldehydic, zesty, citrus peel, pithy, floral and woody notes.

- **Possible applications:** Lime oil distilled characteristic profile of woody, floral alpha terpineol would complement a variety of citrus tonalities, based on lemon and lime notes. The woody, earthy elements make it an essential addition to cola flavor profiles, whereas its floral and resinous character would benefit stone and tropical fruits flavors, as well as white blossom tonalities, like lily and elderflower.

Orange Oil West Indian Type Wild Sweet

FEMA# 2825, CAS# 8028-48-6.

- **Botanical Name:** *Citrus sinensis (L.) Osbeck*.
- **Characteristics:** The wild variety of sweet orange produces oil with a particularly zesty odor, which is primarily used in the flavor industry for beverages and confectionery.
- **Odor Descriptors @ 100%:** Sweet orange, juicy, fresh, ethereal, terpenic, aldehydic, zesty, citrus peel, pithy, floral, woody.
- **Taste Descriptors @ 30 ppm:** Sweet orange, juicy, fresh, pithy, albedo, aldehydic, citrus peel, zesty, green, fruity, slight thyme notes.
- **Possible applications:** Its sweet, juicy, zesty character would provide complexity to various citrus tonalities, like orange, blood orange and grapefruit flavors, while its intense pithy albedo note would complement especially mandarin, clementine and tangerine profiles. The ethereal, floral elements would make it a great addition to stone fruit flavors, like peach and apricot, but also tropical fruits flavors, like passion fruit.

Styrallyl Acetate EU Natural

FEMA# 2684, CAS# 93-92-5.

- **Characteristics:** An ester with molecular formula C10H12O2, found in nature, also known as alpha-methylbenzyl acetate.
- **Odor Descriptors @ 100%:** Rhubarb, leafy, green, metallic, musty, floral, white blossom notes, fruity, sweet candy, over-ripe fruit impression, warm, burnt notes, slight rubbery, herbal, pelargonium leaf notes, ethereal.
- **Taste Descriptors @ 2 ppm:** Rhubarb, leafy, green, metallic, floral, sweet, rubbery, slight plastic notes, fruity, musty, berry, gooseberry, herbal.
- **Possible applications:** Its characteristic green leafy, sweet fruity, musty notes make it an essential element of rhubarb and gooseberry flavors. In combination with its floral aspect, it would provide depth and complexity to grape profiles, as well as tropical fruit tonalities, like lychee and guava. Its sweet candy, slight rubbery impression would benefit stone fruits profiles, like cherry, but also jammy fruity flavors, like berries and strawberry.

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Mapping the Global Senses: Ancient Rituals and Lab Innovations Shaping the Future of Flavor (Part 1 of 3)



The future of flavor is being built in kitchens and labs and cooperatives scattered across six continents.

Image by Tut Mandi at Adobe Stock

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Take a trip around the world with us and discover what ancient and cultural flavors are making an impact.



BY MINDY YANG

Part 2 of this series will appear in the August edition of the magazine; part 3 will appear in the November edition. -Editor

There is a contradiction at the heart of what we eat now. We have never had more access to the world's flavors—every spice, every technique, every fermentation protocol available on a shelf or a screen—and yet most of us, if we're being honest, still reach for the same things we reached for 10 years ago. The future of flavor is being built in kitchens and labs and cooperatives scattered across six continents, and most of it will reach you disguised as something familiar.

What follows is a road map of places where something is genuinely shifting, where the chemistry and the culture and the money are all moving in the same direction at once. Some of it is ancient. Some of it is happening this year. All of it matters if you work in flavor, fragrance, or the increasingly blurred space between them.

Quito, Ecuador — When Fermentation Becomes Authorship

You can tell a lot about an industry by what it treats as invisible. For decades, cacao fermentation was exactly that—something that happened after harvest, in the dark, unremarkable enough that no one thought to put it on the label. That's over now.

Walk into a serious chocolate shop anywhere in the Western world and you'll find bars annotated like wine tasting notes. Seventy-two hours. Estate-fermented. It sounds fussy until you taste what they're actually doing. A bar made from Ecuadorian cacao fermented with a specific yeast strain can taste like stone fruit and jasmine. The same beans, fermented differently, taste like toasted nuts and red wine. The difference isn't subtle.

Based in San Francisco, Dandelion Chocolate released a limited-edition set in April 2024 that took this further than most: cacao fermented alongside cinnamon from



Fermentation can alter the microbial environment of cacao and change the flavor.

Tanzania, nutmeg from India, allspice and black pepper from Belize. The spices are present during fermentation, altering the microbial environment and, consequently, the flavor. The bars tasted like something you couldn't quite name—complex in the way that good wine is complex, which is to say, alive.

Science is catching up to the craft. Researchers at the University of Nottingham mapped the specific microbial succession that produces fine-flavor chocolate and published their findings in *Nature Microbiology*[a]. What happens during a good fermentation is a relay race: yeasts go first, breaking down the mucilage surrounding the beans, then lactic-acid bacteria take over, then acetic-acid bacteria, with temperatures climbing to 50°C. Timing is everything. The Nottingham team went further and created a defined microbial community in the lab that could replicate the outcomes of traditional fermentation—a remarkable feat, though one that raises its own questions about what we're willing to trade for consistency.

[a]*https://www.nature.com/articles/s41564-025-02077-6*

The commercial story doesn't end with chocolate. Cacao pulp—the sweet, fruity flesh surrounding the bean that farmers used to discard or let rot—is now a product in its own right. Blue Stripes has turned it into a juice that tastes nothing like chocolate. It tastes tropical, almost wine-like, and it represents exactly the kind of waste-stream innovation that both environmentalists and accountants can get behind.

And then there's bitterness itself, which is having a broader renaissance that extends well beyond cacao. The U.S. yerba mate market is projected to reach $1.299 billion by 2035, growing at 6.0% CAGR, and the interesting thing isn't the growth—it's what consumers are doing with it.

Rather than sweetening mate, consumers are drinking it bitter, which makes considerably more sense once you look at the underlying biology. Multiple peer-reviewed studies have confirmed that bitter taste receptors—TAS2Rs—exist not just in the mouth but in the gut, where they stimulate GLP-1 secretion, a hormone involved in satiety and glucose regulation. Bitterness, in other words, does something. The wellness industry is

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just now catching up to what South American cultures understood a long time ago.

Oaxaca, Mexico — The 3,000-Year-Old Technique Nobody Took Seriously

There is a woman in Oaxaca who wakes up at 4 a.m. to nixtamalize corn. She has been doing it her whole life. Her grandmother did it before her. The technique itself is older than the pyramids—equipment for it has been dated to 1200 BC in Mesoamerica—and for most of its history, it was simply how corn was prepared.

What nixtamalization actually does, chemically, is extraordinary. Soaking dried corn in warm calcium hydroxide solution—lime water, essentially—triggers a cascade of changes. The pH shift alters the pigment compounds, deepening yellows, turning some varieties a vivid red. The starch partially gelatinizes. The protein partially denatures. Phytic acid drops. And a complex aroma develops that food scientists have spent years trying to characterize—buttery, earthy, savory in a way that feels almost cheesy. They call it "corn chip flavor," which is technically accurate and also completely fails to convey what it actually tastes like when done well, which is closer to something mineral and ancient and deeply satisfying.

Chef Alex Stupak's Empellón restaurants in New York nixtamalize 100 pounds of olotillo blanco corn every single night in their basement. Masienda, the heirloom corn distributor, has spent a decade trying to get the rest of the food industry to pay attention to what Stupak already knew: that the difference between nixtamalized corn and the stuff that goes into commercial tortilla chips is fundamental.

The industry is starting to listen. Beverage developers are experimenting with nixtamalized corn in grain-based drinks that compete directly with oat milk—same ritual of pouring, same creamy texture, but a flavor profile that's genuinely different. Snack companies are exploring chips built on this technique that taste nothing like anything currently on store shelves. The challenge is time. Nixtamalization is inherently slow, and scaling a slow process without losing what makes it special is the kind of problem that keeps R&D teams up at night.

Then there's ceremonial cacao, which quietly went from a niche wellness ritual to something approaching a real category. Brands like Ora and Firefly sell single-origin drinking cacao that is bitter, barely sweetened, often spiced with cayenne or cinnamon. These are not hot chocolate mixes. They are closer to what cacao was before colonialism—a drink with spiritual weight, designed to be consumed slowly and with intention. The format works because it offers something the market has been starving for: a ritual with genuine history behind it, one that doesn't require you to buy anything you can't pronounce.

Bamako, Mali—The Grain That Grows Where Nothing Else Will

Fonio has been cultivated in West Africa for more than 5,000 years. Archaeologists found it buried in Egyptian tombs. For most of that time, it was simply what people ate—unremarkable, foundational, beneath the notice of anyone writing trend reports.



Nixtamalization is an ancient process of soaking dried maize in an alkaline solution.

Image by jesus at Adobe Stock



Fonio is rich in protein, fiber, iron and essential amino acids.

The grain is drought-resistant and almost absurdly fast-growing, producing a harvest within six to eight weeks of planting. It thrives in sandy, low-quality soils where other crops fail entirely. Bill Gates wrote about it in 2024, calling it "farming on easy mode." West African farmers have their own term for it: the lazy farmer's crop. Both descriptions undersell it. Nutritionally, fonio is serious—rich in iron, high in methionine and cysteine, amino acids that most grains lack entirely.

Chef Pierre Thiam, who has spent years trying to bring West African ingredients into mainstream conversation, co-founded Yolélé Foods to commercialize fonio in the U.S. The company works with nearly 1,000 smallholder women farmers in Mali and has figured out how to reduce losses during threshing and dehulling from 50% to about 20%—a logistical achievement that made the economics viable. The supply network has increased farmer earnings by as much as 30%.

For flavorists, the appeal is both agricultural and sensory: fonio is nutty, mildly mineral, neutral enough to absorb other flavors while contributing a subtle complexity of its own. It is showing up in gluten-free pasta, fermented beverages and grain bowls positioned as climate-resilient, which, given what's coming, may turn out to be one of the more important selling points of the next decade.

Teff, Ethiopia's ancient grain—the only cereal high in vitamin C—is on a similar trajectory, driven largely by the gluten-free market but earning attention from flavorists for its own sake. The flavor is nutty, mildly sour, earthy in a way that feels earned rather than imposed.

But the story out of Africa that deserves the most attention from flavor houses has to do with smoke and fermentation. African smoke profiles are structurally different from what Americans know. They're dry, almost mineral, produced by open fire and specific woods that smell closer to incense than bacon. The smoke layers over time rather than dominating from the first bite—a quality that is difficult to replicate with liquid smoke and almost impossible to mass-produce without losing what makes it distinctive.

Then there's dawadawa—fermented locust beans, used across West African cuisines with the same quiet authority that miso carries in Japan. It's funky, deeply umami, and flavor houses are now studying its fermentation process and microbial profiles with genuine interest, not as a curiosity but as a potential platform for umami development that doesn't depend on soy. Ethiopian berbere is being deconstructed for similar reasons—its particular alchemy of chiles, fenugreek, and aromatics works in ways that aren't fully understood, and understanding it could open doors in both savory and, surprisingly, chocolate applications.

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Beyond the Scent: DESIGNING INTEGRITY THROUGH TRACEABILITY

In the next era of fragrance, traceability will separate those who simply source ingredients from those who design with integrity.

BY ASHLEE POSNER



Traceability is what enables responsible decision-making, because it brings the conversation back to what can be verified: composition, sourcing, quality parameters and documentation.

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In fragrance, scent is only part of the story. What increasingly matters, especially to informed, conscientious customers, is where materials come from, how they're made and why they're used. Traceability is no longer a behind-the-scenes compliance exercise; it's a design principle that shapes quality, safety and trust.

At its simplest, traceability means being able to follow every ingredient from origin to finished formula. In practice, it's more nuanced. It requires understanding raw material sources, cultivation and harvesting conditions, extraction methods, purity and composition, and supply-chain integrity, then documenting those details in a way that is accurate, consistent and useful.

This matters in every segment of fragrance, but it becomes especially consequential in a natural-forward landscape. Essential oils, extracts and natural isolates bring remarkable character—yet they also bring variability, complexity and sourcing realities that can't be solved with marketing language.

Why Traceability Matters

Fragrance ingredients, natural or synthetic, are chemistry. Traceability gives brands and perfumers the ability to work with materials that have defined composition and reliable documentation. When components are known and recorded, formulas can be evaluated more precisely, allergens can be managed intentionally and usage levels can be set with greater confidence.

For naturals, traceability is also the foundation of consistency. Climate shifts, harvest timing, soil conditions and extraction parameters can change the olfactive profile of a material from batch to batch. A lavender oil is not a static input; it's a living expression of geography and process. When a brand has strong traceability, origin documentation, lot tracking and specifications that reflect real-world variability, it becomes possible to maintain a signature scent over time without overcorrecting the formula or sacrificing integrity.

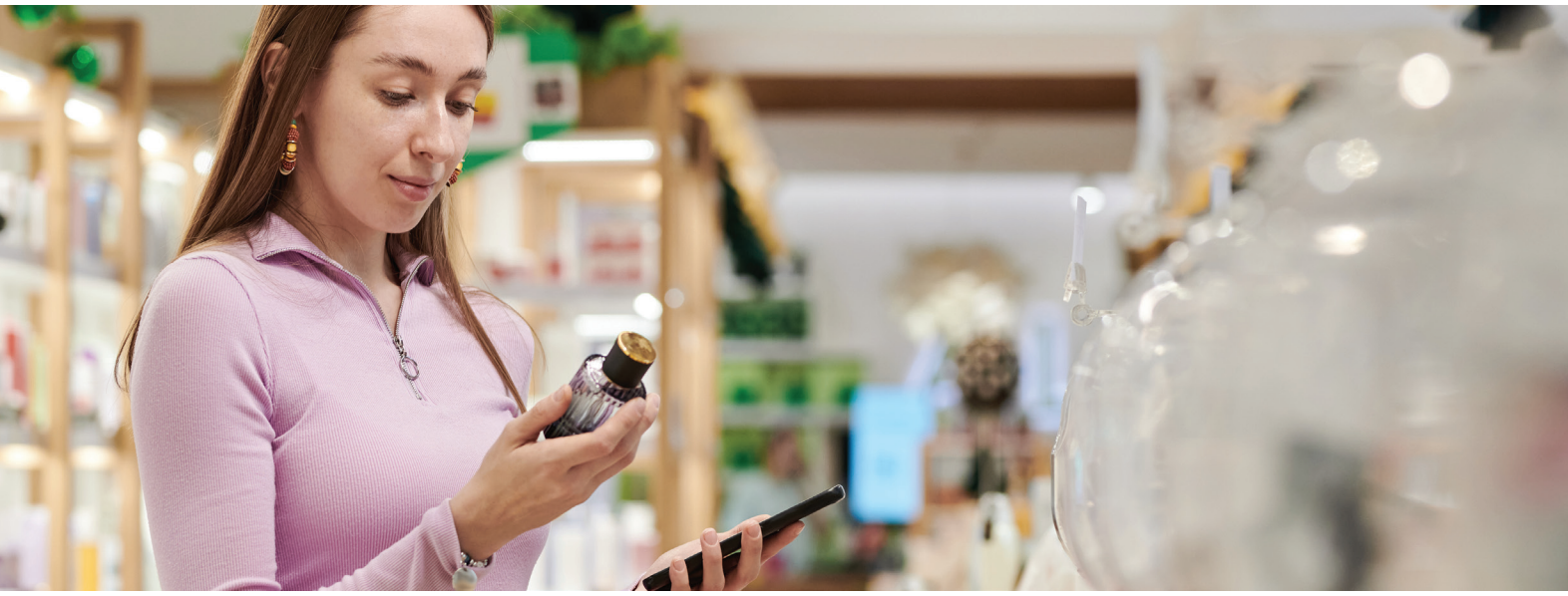
Traceability Reframes the Natural vs. Synthetic Conversation

A traceability-first approach also changes the way we talk about "natural" versus "synthetic." The real question isn't which category is "better" in theory—it's which ingredient is better understood, responsibly sourced and appropriate for the intended product at the intended use level.



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A lavender oil is not a static input; it's a living expression of geography and process.



Transparency doesn't mean overwhelming consumers with technical language. It means communicating in a way that is truthful, consistent, and useful while being able to stand behind the information when asked.

Naturals can be extraordinary and complex. High-quality synthetics can offer consistency and precision. Standardized natural fractions and isolates can bridge the gap. In all cases, traceability is what enables responsible decision-making, because it brings the conversation back to what can be verified: composition, sourcing, quality parameters and documentation.

The Operational Reality: Sourcing, Logistics and Documentation

Traceability is also an operational discipline. It lives at the intersection of sourcing practices and supply chain execution. As brands scale, the questions become more specific:

- Can you trace this material to a defined origin and supplier network?
- Are you tracking lot-to-lot variation and setting realistic specifications?
- Do you have documentation that survives importing/exporting requirements and changing logistics constraints?
- Can you substantiate claims without relying on vague language or implied purity?

When shipping lanes shift, harvests fail, or suppliers change, traceability becomes a stabilizer. It allows teams to evaluate substitutions intelligently, maintain quality and document changes transparently, rather than patching the formula assuming everything is equivalent.

What Transparency Looks Like in Practice

For a fragrance brand centered on transparency, traceability shows up in tangible, repeatable behaviors, not just storytelling:

- Clear ingredient categorization (what it is and why it's there)
- Defined sourcing standards and supplier vetting
- Lot tracking and specifications that reflect real natural variability
- Intentional material selection based on safety, stability and performance
- Honest communication: no vague claims, no implied purity, no hiding behind "proprietary" where clarity is possible

Transparency doesn't mean overwhelming consumers with technical language. It means communicating in a way that is truthful, consistent and useful while being able to stand behind the information when asked.

The Future of Fragrance

Traceability is becoming a marker of quality, not just compliance. Consumers are asking smarter questions, retailers and partners are asking for better documentation and brands are discovering that trust is built through evidence, not aesthetics.

In the next era of fragrance, traceability will separate those who simply source ingredients from those who design with integrity. The brands that can answer questions with clarity, confidence and documentation won't just keep pace. They'll set the standard.

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Penta Fine Ingredients has supported the Flavor and Fragrance industry for over 45 years.

Here is a partial listing of our Family Naturally derived Flavor and Fragrance ingredients.

For detailed paperwork on all of our items consult our web site at www.pentafineingredients.com

- NATURAL 2-ACETYL PYRAZINE
- NATURAL AMBRETTOLIDE
- NATURAL 4-HEPTANONE
- NATURAL BENZOIC ACID
- NATURAL ALPHA-BISABOLOL
- NATURAL VALENCENE
- NATURAL NOOTKATONE
- NATURAL 1-OCTEN-3-OL
- NATURAL ISOPHORONE
- NATURAL CARYOPHYLLENE OXIDE
- NATURAL CIS-3-NONENOL
- NATURAL ETHYL-3-HYDROXY BUTYRATE
- NATURAL FENCHYL ALCOHOL
- NATURAL SULFUROL
- NATURAL 2,3-DIMETHYL PYRAZINE
- NATURAL 2,6-DIMETHYL PYRAZINE
- NATURAL METHYL-2-NONENOATE
- NATURAL ETHYL ANISATE
- NATURAL DELTA NONALACTONE
- NATURAL ETHYL LINOLEATE
- NATURAL ETHYL-2-METHYL BUTYRATE
- NATURAL 2-ETHYL-3-METHYL PYRAZINE
- NATURAL METHYL ETHYL KETONE

For a complete list of all our natural, natural identical and synthetic ingredients visit us at www.pentafineingredients.com

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