ISSUE 68 2025

IFEAT WORLD

INTERNATIONAL FEDERATION OF
ESSENTIAL OILS
& AROMA TRADES

GÖTEBORG CONFERENCE REPORT

MY FAVOURITE: SANDALWOOD

FIELD TRIP REPORT

IFEAT 2025 GÖTEBORG

ADVOCACY BULLETIN

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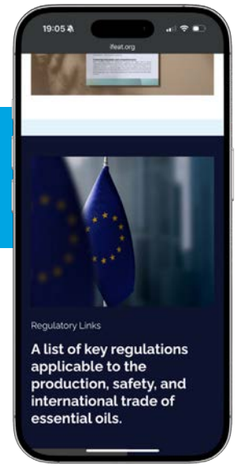
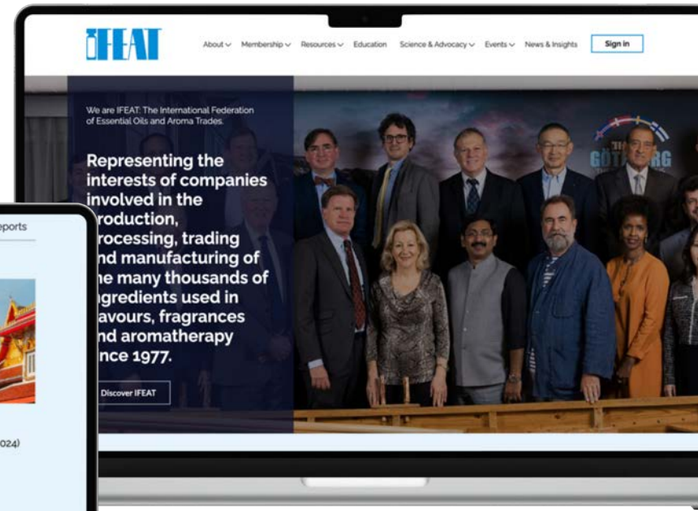


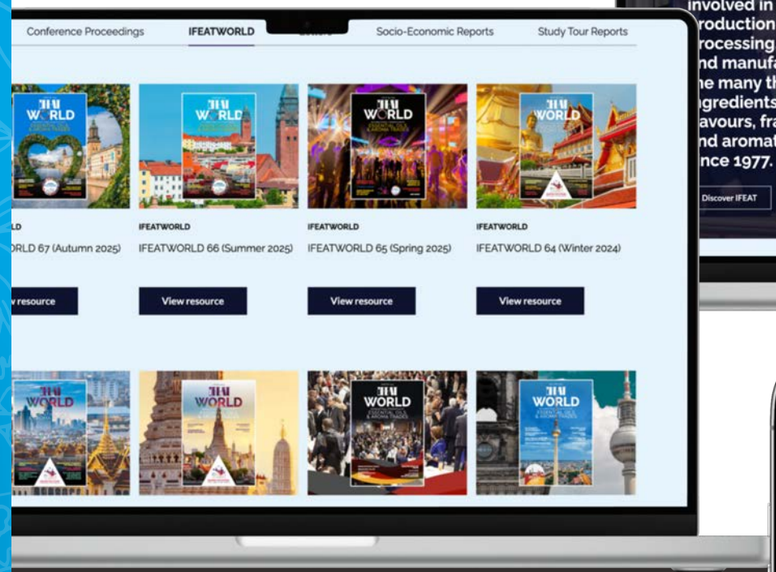
In November, we launched the brand new **ifeat.org**.

If you haven't already, please visit our new website – sign in, and populate your company's profile in the Members' Directory, too!

You can log in using the same email address as you used for our previous website – you'll just need to reset your password on your first visit.

We're still busy bringing some content and functionality into the site, but we hope you enjoy the fresh new look and feel as we continue to make improvements.





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Welcome from the Chair

IFEAT's newly elected Executive Committee Chair, Dr Geemon Korah, welcomes you to the Winter 2025 edition of IFEATWORLD.

It is with immense gratitude and excitement that I write to you as the newly elected Chair of IFEAT. I am deeply honoured by the trust placed in me by our esteemed Members and Directors, and I look forward to serving this vibrant global community with dedication and vision. My first IFEAT Conference was almost 30 years ago and I have never missed any since, barring the Vancouver Conference. When I first came to be part of the IFEAT family, I was young, inexperienced and enthusiastic about our industry. That I have continued to be part of this wonderful industry of ours is also a testimony to the role of IFEAT, and how it has contributed to both personal and professional growth to all those involved.

This year in Göteborg as I was witnessing the Young IFEATians session, it took me back to those early days. The positive energy and vibes of this session should leave us all with the satisfaction that the future of our industry is in good hands.

The **2025 IFEAT Conference in Göteborg** was a resounding success, bringing together 1,720 industry leaders, innovators, and passionate professionals from across 64 countries. The energy, insights, and camaraderie shared during the event reaffirmed the strength and unity of our global network. The Göteborg Conference is now the most successful IFEAT Conference ever held in Europe. Thanks to the wonderful team lead by Zahra Osman Guelle from the Executive Committee and Shaehzad Chaudhry from IFEAT Staff team supported by our Company Secretary, Louise Kapor, and our able team of Ronit Meier from Finance, Simon Frost from Communications, Lindsay Smith and Sheila Russell from Education, Divya Sara Mammen from Study Tour, and Jisha Das from Socio-Economic.

The Young IFEATians event was a reminder that the future of our industry is in very good hands!

I would like to extend heartfelt thanks to **Catherine Crowley**, our Immediate Past Chair, for her outstanding leadership over the past three years. Her commitment and strategic guidance have left a lasting impact on IFEAT. There are quite a few projects that were initiated over the last three years which will continue to drive our industry agenda going forward.

Catherine Crowley's commitment and strategic guidance have left a lasting impact on IFEAT.

Special appreciation also goes to **Csaba Fodor**, who stepped down from the Executive Committee after **two decades of selfless service**, recently completing a Co-option role. His contribution has helped shape the foundation of our organisation with significant contributions in Finance and Education. Likewise, we honour **Hussein Fakhry**, our Past Chair, for **over 20 years of dedicated service** and for continuing to lend his expertise through the Socio-Economic Committee.

The **New Members' Forum and Young IFEATians** in Göteborg were a highlight, fostering fresh connections and ideas. We were thrilled to welcome **Agnes Gendry-Hearn from Lush UK** to the Executive Committee, bringing new perspectives and energy to our leadership team with her expertise in the consumer side of the business.

We are thrilled to welcome Agnes Gendry-Hearn to the Executive Committee – be sure to read her "My Favourite" article on page 26.

Sustainability remains a core focus for IFEAT. The launch of the **Sustainability Awards** in Göteborg marks a significant milestone in our journey toward a cleaner, greener future. We hope this initiative inspires all Members to contribute meaningfully to environmental stewardship.

On the advocacy front, IFEAT continues to engage with **EU policymakers** to ensure our industry's voice is heard and supported. This work is vital to safeguarding the future of our sector. We shall keep you updated on all developments on this front on a regular basis. It is vital that everyone understands and contributes to this exercise.

Csaba Fodor (L) and Hussein Fakhry (R) have served IFEAT tirelessly for the past two decades.

It was a great pleasure to announce the winners of our inaugural Sustainability Awards in Göteborg.

The **Australia Study Tour, due to take place in March 2026**, sold out in record time, reflecting the enthusiasm and commitment of our Members to continuous learning and exploration. Study Tours have now become one of the most rewarding experiences that IFEAT provides our Members. This is today ably co-ordinated by Stephen Pisano – and I'd like to give a special thanks for his fantastic work, having taken over from the most knowledgeable and fun-loving Peter Greenhalgh, who we still reach out to for guidance. We look forward to more such enriching experiences.

IFEAT 2026 ABU DHABI CONFERENCE
11-15 OCTOBER • YAS ISLAND UAE

Finally, I invite you all to look ahead to the **IFEAT 2026 Conference to be held at Yas Island, Abu Dhabi** – a destination that promises to blend tradition with modernity in a truly spectacular setting. It will be an event to remember.
Thank you once again for your trust and support. Together, we will continue to build a stronger, more sustainable, and inclusive future for our industry.

Warm regards,

Geemon Korah
Chairman, IFEAT

Göteborg Conference Report: the Nordic Nexus delivers

The IFEAT 2025 Göteborg Conference speaker programme was an ambitious, record-breaking series of 11 sessions featuring 43 experts, tackling global economic shifts, regional growth and the sustainable future of the supply chain.

Hosted for the very first time in the Nordic region, the IFEAT 2025 Göteborg Conference brought together 1,720 delegates from 64 countries – a record attendance for any IFEAT Conference in Europe. The event's central theme, The Nordic Nexus, celebrated the progressive values of sustainable innovation permeating the region, anchored by Göteborg's status as a global leader in environmental stewardship.

With the Nordic essential oils and aroma market experiencing consistent growth, the Conference also offered an unprecedented insight into the region's unique business culture and world-leading focus on sustainability. A hugely ambitious, expansive speaker programme, with a record 43 speakers over 11 sessions, was expertly curated by Conference Chair Zahra Osman Guelle and IFEAT Education Manager Lindsay Smith, supported by the wider Conference Committee. And it all began with two influential Swedish thinkers – providing very different, but equally challenging, keynote perspectives on the future of global business.

The Post-Global World

Dr Kjell Nordström, an acclaimed writer, speaker and authority on international business, delivered a dynamic keynote that positioned the current volatile global landscape as a developing "Polaroid photo" constantly being shaped by a set of dominant, seemingly uncontrollable forces.

Nordström outlined five fundamental shifts dictating the direction of the world economy. The first is Hyper-Urbanisation – the relentless growth of urban environments. Citing the staggering forecast that 80% of the global population is projected to live in approximately 600 large urban entities by 2050, Nordström emphasised that cities act as "hope machines" which draw human migration. He noted that companies are increasingly becoming "multi-urban" – rather than multinational – focusing their strategies on specific high-density economic hubs.

The second major force is Intelligence as a Service, where technology is turning fundamental knowledge into a "pay-and-play" service. This shift necessitates a new focus for education and industry: concentrating on skills (such as comforting a patient or the art of negotiation) rather than easily streamable knowledge. This re-prioritisation, Nordström suggested, will lead to the growing importance of tacit knowledge – the silent, embodied expertise that human beings know but cannot easily articulate.

The third shift is The Rise of Oligons, as the optimistic era of globalisation yields to a world divided into three to seven smaller, competing civilisations. These blocs, he said, will increasingly set their own technological and value-based operating principles, resulting in the rolling back of multinational operations and the return of physical and virtual trade walls.

The fourth transition involves The Stream of Payments, where traditional transactions are giving way to continuous, low-cost streams of payment. Nordström predicted a future where ownership is replaced by use-based payment streams.

Finally, the fifth shift is Environmental Integration. While environmental concern is now fully integrated into the economic system, Nordström warned that merely "going green" is a "necessary but insufficient condition for success". Nordström argued it is the new baseline, not a competitive advantage – and companies that fail to integrate environmental stewardship will not even get to play the game.

Regenerative vs Extractive Economy

Following this challenging economic outlook, Dr Anders Wijkman, a Swedish politician, opinion leader and co-President of the global think tank Club of Rome, offered a stark, sobering view of the "full world". He argued that the phenomenal post-WWII economic growth, driven by technology and trade, was fundamentally underpinned by cheap, abundant energy and materials – conditions that no longer hold true.

Wijkman immediately brought into sharp focus the planet's deteriorating health, noting that humanity has now transgressed six of the nine established planetary boundaries. Crucially, he delivered a shocking finding from the International Resource Panel: the extraction and processing of materials alone result in 55% to 60% of global greenhouse gas emissions and 90% of biodiversity loss. The core problem, he asserted, is the linear "take, make, dispose" economic model and the continued use of GDP as the chief measure of progress.

Wijkman's solution lay in an absolute decoupling of resource use from growth, particularly by high-income countries, advocating for a transformation towards a circular and regenerative economy. For the essential oils sector, he specifically championed regenerative agriculture – a farming approach designed to maximise photosynthesis, build carbon in the soil, and increase fertility, thereby minimising environmental footprint and enhancing biodiversity. He urged the IFEAT community to adopt these principles and to advocate strongly for policy frameworks that incentivise this shift. In closing, Wijkman offered a profound philosophical challenge: "The major problems of the world are the result of the difference between how nature works and the way people think."

Wonders of Wood

High-level economic discussion transitioned into the supply chain, with the "Wonders of Wood" session, showcasing innovative and circular approaches to forest-based essential oils from around the world. These case studies demonstrated that environmental sustainability is not just aspirational, but technologically achievable and economically sound.

The session featured Martin Lersch of Borregaard, who detailed the operation of the Norwegian biorefinery. Borregaard uses 94% of every metric tonne of wood feedstock. This commitment allows their wood-based vanillin to boast a carbon footprint 29 times lower than fossil-based competitors – a compelling case for industrial symbiosis.
This was followed by Jean-Claude Villeneuve of BoreA, who presented a powerful model of a circular economy ecosystem in the remote Canadian boreal forest. His company upcycles the waste (twigs and needles) left behind by the logging industry, even exchanging their distillation residue for steam energy with a nearby power plant. Beyond the process, Villeneuve stressed the importance of human capital, community involvement, and local resilience.

Hraundís Guðmundsdóttir shared her journey as a distiller in Iceland, a country rapidly expanding its tree cover. Her company, Hraundís, operates on pure upcycling, using leftovers from thinning, pruning, and windfall coniferous trees, speaking to the essential, grounding role of her oils in connecting people to Iceland's unique, changing nature.

Finally, Nicolas Blaser of Alpes Cambium illustrated his company's dual valorisation model in the French Alps. They collect branches and needles within 24 hours of harvest to preserve potency. This biomass is used to create essential oils, with the remaining 80% converted into renewable energy and compost for soil regeneration. Blaser stressed that the long-term health of the industry depends on climate-resilient sourcing and full traceability, noting there is significant room for improvement, estimating only 20% of European forestry companies utilise this proper, holistic perspective of forestry.

The Family Forum

The focus on the "People" pillar of sustainability was deeply reinforced by the Family Forum, moderated by Dr Kajsa Haag of Jönköping International Business School. Dr Haag noted that family firms are the global norm and are often characterised by a long-term, generational perspective. This, she argued, makes them "unbeatable in competition when they manage to innovate based on their own tradition."

Wonders of Wood session speakers took part in a panel discussion.

The session featured panellists representing the first to the fifth generation of family businesses, all tackling the core challenge of succession. Alan Brown (The Lebermuth Co., Inc.) and John Nechupadom (Plant Lipids) described highly structured apprenticeship models, ensuring "well roundedness" and deep technical immersion for the next generation. As Mr Brown noted, while a standard business might suggest 10,000 hours to become an expert, "I think for the flavour and the fragrance industry, you need to double that. You really need about 10 years to become an expert."

The panellists' diverse journeys provided compelling anecdotal evidence. Rovena Raymo (Simone Gatto) shared a structured upbringing that included travel with her father to meet customers and required external internships, embodying a proactive, eye-opening approach to preparation for the family business. In contrast, Kim Bleimann (Berjé, pictured above) admitted to having "no intention" of joining the business until an unexpected car repair bill forced his entry, the spontaneous nature of some transitions.

First-generation founder Murat Yasa (Aromsa) and Jean Mane (V. Mane Fils) stressed passion and technical expertise. Mane, whose eldest daughter was unanimously chosen to lead the fifth generation, expressed his profound pride in her choice, but stressed the importance of not forcing the next generation into the business. The panellists agreed that the attractive and passionate nature of the flavour and fragrance industry itself helps retain talent, providing the "rocket fuel" for continuity. The session concluded that successful, multi-generational firms must master three areas: balancing financial and non-financial goals, innovating based on legacy, and actively managing the lengthy process of succession.

AGM and Business Session

The 2025 Annual General Meeting (AGM) and Business Session reflected a year of growth, strategic advocacy, and operational success for the Federation. Under the stewardship of President Ramon Bordas and Chair Catherine Crowley, the session reinforced IFEAT's commitment to protecting and developing the global essential oils industry against a backdrop of increasing regulatory complexity.

The formal proceedings began with Company Secretary Louise Kapor reading the ordinary business of the meeting – namely the reappointment of Menzies LLC as the Federation's auditor, and the re-election of numerous Executive Committee Members for new three-year terms, as well as the election of one new Director, Agnes Gendry-Hearn of Lush, UK, who was formally welcomed to the Executive Committee.

Mr Bordas oversaw the successful re-election of Committee Members, demonstrating the Federation's stable governance, while Members unanimously adopted the Executive Committee's Report and Accounts for the year ending December 31, 2024, confirming IFEAT's strong financial footing.

A moving moment came with a tribute paid by Mr Bordas to Hussein Fakhry, who retires from the Executive Committee after 21 years of service. Mr Bordas lauded Fakhry's enormous contributions, highlighting his role as the organiser of the successful 2007 Egypt Study Tour and the spectacular 2016 Dubai Conference. His tenure as Executive Committee Chair from 2019 to 2022 was crucial in steering the Federation through the challenges of the COVID-19 pandemic. Being handed the microphone during a long applause following the President's tribute, Mr Fakhry joked, "I don't think I have much to say – I'll just give you your cheque for the nice words you said for me. Thank you, Ramon. Thank you, everyone. Thank you very much."

The Outgoing Chair's Review

In her final report as Chair of the IFEAT Executive Committee, Catherine Crowley provided a comprehensive review of the past three years, emphasising the Federation's trajectory. Crowley reported phenomenal growth, with membership rising from 672 at the end of 2022 to a current high of 780 Member companies. This growth, she noted, is a clear reflection of collective hard work and the relevance of IFEAT's activities.

Financially, IFEAT maintained a healthy surplus of income over expenditure, funds which the Executive Committee is actively strategising to reinvest into projects that directly benefit the membership.

The Bangkok 2024 Conference was celebrated as a landmark success, welcoming over 1,730 attendees from 66 countries. Crowley recalled the spectacular event highlights, including the vibrant funfair-themed Welcome Reception, the hugely entertaining Closing Banquet and the IFEAT Dinner, a cruise on the Chao Phraya River which featured a breathtaking 300-drone show celebrating IFEAT in the Bangkok night sky. Other 2024 successes included two highly successful Study Tours – to Calabria and Sicily (focused on citrus oils) and Turkey (focusing on rose, oregano, and lavender).

Advocacy and Education Work

The outgoing Chair underscored the critical necessity of IFEAT's ongoing advocacy work, particularly in response to developing European Union policies.

Advocacy efforts continue on the vital "Essential Use" concept, focusing on the distinction between risk and hazard to prevent unintended consequences for natural products. A significant challenge addressed last year was the European Chemicals Agency's (ECHA) proposed reclassification of Tea Tree Oil. IFEAT, in a joint submission with industry partners, has been closely monitoring and challenging such recommendations to protect the industry's interests.

Central to the Federation's long-term strategy is the creation of the joint Scientific Platform. Following the achievement of the vital derogation under CLP for multi-constituent essential oils, IFEAT and EFEO, alongside other participants, are now forming a consortium to launch a substantial fundraising effort. This platform will compile the rigorous scientific evidence required over the next four years to validate and permanently maintain this derogation – a crucial protective measure for the natural products sector.

Finally, in education, work is intensively underway to transform the industry-renowned ICATS Online Learning Programme into an interactive e-learning platform, complete with new modules and a dramatically expanded e-library, ensuring the Federation continues to invest in the industry's future talent.

Crowley concluded her tenure as Chair by sharing her view that "The essence of IFEAT, I believe, is in the nature of the people who lead it." She emphasised that the Directors' work is sacrificial, motivated not by status or ego, but by a genuine commitment to serve the membership, and that the Federation's staff and consultant team is similarly inspired and dedicated to IFEAT's work.

The message of the session was clear: IFEAT is thriving, growing stronger, and dedicating its resources to navigating the challenges ahead with passion and collaboration.

IFEAT Medal Lecture: Jean Mane's Call for Common Sense

Jean Mane's IFEAT Medal Lecture provided a compelling blend of personal history and industry critique, and a powerful defence of the F&F industry's products.

Jean Mane's IFEAT Medal Lecture was a remarkable address that blended autobiography, sharp industry critique, and a passionate defence of natural products. The talk served as a stirring call for pragmatism in regulatory oversight, and earned a spine-tingling standing ovation, as longstanding industry colleagues recognised his exceptional leadership, talent, and humanity.

Mr Mane ("Don't call me Doctor" he jokingly began, clarifying that he holds a Master's degree, not a PhD) delivered a vibrant retrospective of nearly five decades at V. Mane Fils. He colourfully recounted his beginnings as a research chemist, where he was perhaps "the most explosive chemist" his mentors had ever seen, frequently turning bench experiments into "ceiling art".

His hard-won experience – where triumphs with sulphur compounds were balanced by spectacular blunders such as the "great chocolate eruption incident" where a scaled-up Maillard flavour "erupted like Vesuvius covered in Nutella" – taught him the essential lesson of humility. This was an address laced with a good natured and often self-effacing humour that kept the audience smiling and laughing throughout. But this very personal lecture was also underscored by a core theme: the need for realistic, grounded thinking – a concept he lamented was severely lacking in modern regulation.

Regulatory Nonsense

The main thrust of Mane's lecture was his decades-long battle against what he termed "regulatory nonsense". He questioned the industry's initial categorisation as part of the "infamous chemical industry", arguing this historical misstep had created the platform for current oversight. He highlighted the absurdity of the regulatory paradigm's shift from risk analysis to hazard eradication and its rigid application of the "one substance, one assessment" principle, which is ill-suited to complex natural substances. Mane used historical touchstones, like Dr Richard L Hall's 1977 paper Safe at the Plate, which demonstrated that countless natural foods contain substances that would fail the regulatory scrutiny placed upon manmade ingredients, to illustrate this point.

Striking examples included coumarin, which recent studies suggest is far less toxic than prevailing dogma dictates, but remains shackled by outdated classification due to reluctance from regulatory bodies to admit error. And smoke flavourings – which, though previously deemed safer than traditional food smoking, are now flagged as genotoxic after EFSA mandated the testing of isolated constituents rather than the complex natural substances. Mane pointed out the irony that traditionally smoked foods remain unregulated and uncontrolled in their content of polyaromatic hydrocarbons.

Mane stressed that the history of use from our food is the most sound basis for evaluating flavouring safety, arguing against relying on unrealistic high-dosage studies that do not reflect realistic exposure. He noted that common sense prevailed when German authorities exempted traditional cookies containing excessive cinnamon from reformulation.

Naturals and Olfaction as Essential

In his concluding remarks, Mane championed the cause of natural extracts and the fundamental importance of olfaction. He satirised regulations, recalling his past warning not to inform regulators that Mother Nature emits 100 million tonnes of volatile organic compounds (VOCs) annually, lest new laws prevent walking in pine forests. And he championed the recent EU exemption for natural extracts, but emphasised that this status is conditional upon producing robust scientific evidence.

This requirement is driving major industry initiatives: the IFEAT-EFEO Scientific Platform is coordinating research to demonstrate that natural extracts must be assessed as complex entities, and Mane's own company has initiated a PhD research project on neuroscience focused on olfaction's fundamental role in human health, emotional wellbeing and memory – designed to provide a solid scientific contribution to the debate on essential uses – a cornerstone of the upcoming REACH 2.0 legislation. He recalled how his own life, having been "bathed in a sense of essential oils" since childhood, proved the enduring and non-hazardous nature of these materials.

Mane's final advice was a powerful call to unity, pragmatism, and science over dogma, urging the industry to adopt "good old farmers' common sense" – a crucial balance between science, nature, and responsible industry.

The sharp vision, humour, and humanity that permeated Jean Mane's IFEAT Medal Lecture left the audience tangibly moved, as they recognised an exceptional career dedicated to the flavours and fragrances sector.

Education Session

The Education Session celebrated the recent advances in IFEAT's educational offerings, and teased its future trajectory.

Led by Alan Brown, Chair of IFEAT's Education Committee, the Education session provided a detailed look at the continuing development of the International Centre for Aroma Trades Studies (ICATS) course, followed by an in-depth presentation by student Marina Périco on her experience of the University of Reading Flavourist Course and its practical applications.

ICATS Annual Review and Digital Transformation

Alan Brown opened the session by presenting the ICATS Annual Report, highlighting a significant evolution in the delivery of the curriculum. In response to the changing needs of the industry, IFEAT's Education Committee, Education Manager and Education Programme Officer, supported by industry experts, have continually refreshed the course materials to function on a bespoke online platform. Brown noted that the programme is moving away from static learning models to embrace media-rich content, including podcasts, micro-learning videos, and academic discussion forums. This shift will ensure that the educational content remains not only current but also engaging for students who are balancing their studies with professional obligations.

The report noted that the ICATS student cohort continues to grow in diversity, currently comprising individuals from 14 different countries with an age range spanning from 19 to 52 years. Brown highlighted that many of these students are newly employed in the industry, with the asynchronous, flexible nature of the programme allowing them to build upon their knowledge base while working full-time.

A significant portion of the report was dedicated to celebrating academic excellence. The ICATS Best Student Award was presented *in absentia* to Sascha Schreiber, Director of Global Product Development at Estée Lauder. Her dissertation, which focused on intellectual property protection in perfumery, was lauded for its depth and relevance, having led to further research on "olfactory authorship" published in the *Journal of World Intellectual Property*. Brown cited this as a prime example of how ICATS encourages students to contribute to the wider industry beyond their immediate corporate roles.

The session also served as a moment to honour the legacy of Dr Tony Curtis, ICATS' founding academic leader, who retired in May 2025. Brown paid tribute to Dr Curtis for shaping the curriculum and mentoring generations of students, acknowledging that his work built the global reputation that ICATS enjoys today.

Technical Training: The University of Reading Flavour Course

Following the Chair's annual report, the session transitioned to a focus on technical application with a presentation by Marina Périco regarding the University of Reading Flavourist Course, a collaboration between the British Society of Flavourists and the University of Reading. Périco offered a detailed retrospective of the intensive three-week programme, which is designed to provide a comprehensive understanding of flavour characteristics and their application in food systems.

Périco described the course as a rigorous blend of theory and practice. Students engaged in the assessment of over 100 flavour compounds, studied European and worldwide legislation, and participated in field trips to essential oil extraction facilities. A core component of the training involved "practical creativity", where students were tasked with creating flavours for specific applications. Périco shared her personal success in developing a pineapple flavour with sweet, ripe, and sulfurous notes for yoghurt, as well as a green apple flavour characterised by green skin and acidic notes for sparkling water.

Since its inception in 2002, the course has graduated 241 students from over 40 countries, facilitating a vital exchange of knowledge and cultural perspectives. During a brief discussion with moderator Catarina Rolfsdotter-Jansson, Périco noted that cultural background often influences flavour creation, citing the popularity of pineapple in her native Brazil as a driving factor in her project choices.

The session concluded with the presentation of student medals to both Sascha Schreiber (*in absentia*) and Marina Périco, recognising their respective contributions to academic research and practical application. The overarching message of the session was one of accessibility and connectivity; whether through the digital reach of the ICATS platform or the intense, in-person collaboration at the University of Reading, IFEAT remains committed to fostering a highly skilled, globally connected network of professionals through its education programme. With the next Reading course scheduled for June and already at capacity, it's clear that the demand for high-quality industry education remains robust.

Cracking the Code of Plant Extracts

Dr Jonathan Bonello, IFEAT Scientific Program Officer, provided an insightful report on how science meets regulation to protect the business of plant extracts and associated natural complex substances.

Dr Bonello commenced his address by emphasising the evolving regulatory landscape, specifically the revised EU CLP Regulation (EC) No 1272/2008 on the classification, labelling and packaging of substances and mixtures, and the EU REACH Regulation (EC) No 1907/2006 concerning the registration, evaluation, authorisation and restriction of chemicals, both of which present significant implications for the natural extracts industry. He illustrated the core problem with the proposed application of the More than One Constituent (MOCS) principle, which dictates that mixtures must be classified based on the known hazards of their components.

Using a compelling example, Dr Bonello demonstrated how this principle fails natural products. p-Cymene, a constituent in many essential oils, is classified as a Reprotoxic 1B substance with a NOAEL of 50 mg/kg. NOAEL (No Observed Adverse Effect Level) refers to the highest tested dose at which no statistically or biologically significant adverse effects are observed compared with a control group, and is a key toxicological parameter. Since p-cymene appears in *Eucalyptus globulus* essential oil at concentrations exceeding the regulatory threshold, the MOCS principle suggests the entire oil must carry the Reprotoxic 1B label. However, Dr Bonello noted that testing the whole oil yields a completely different result. He stated: "You see from the REACH registration dossier for *Eucalyptus globulus* essential oil itself, the result is that there is no reproductive effect from the same OECD 422 test."

This discrepancy illustrates how the natural matrix significantly influences the biological activity of the oil. Dr Bonello also highlighted the dosage paradox, noting that the NOAEL for whole Eucalyptus globulus essential oil is 1,000 mg/kg; twenty times higher than that of the isolated component. Such evidence strengthens the argument that essential oils must be regarded as distinct, complex single substances rather than straightforward mixtures of their individual constituents.

Securing the Future

Thanks to significant industry efforts, a temporary derogation from the MOCS principle for plant extracts was secured until December 2029. The EFEO-IFEAT Scientific Program's mission is to provide the robust scientific data required for the European Commission to maintain this exemption.

The Program is guided by three core objectives:

- To provide clear analytical, toxicological and environmental evidence demonstrating the differing behaviours of whole oils versus isolated constituents;
- To justify that essential oils should be recognised as unique single substances, both chemically and functionally;
- To demonstrate that, by inference, the MOCS approach is not appropriate for these natural extracts.

Organisation and Scientific Execution

The Program operates through a Steering Committee composed of EFEO and IFEAT leaders, overseeing implementation, scientific coordination and fundraising. Dr Bonello recalled the importance of continuous dialogue with the European Commission, emphasising that "There's not much point in us coming up with a report and submitting it in four years' time, and then the authorities saying, 'Well, this is not actually what we needed.'"

The Program collaborates with a wide array of supporting associations, including CIHEF, COSMED, Cosmetics Europe, IFRA, IOFI and Natrue, ensuring aligned industry communication and a unified scientific voice.

Dr Bonello outlined the work of the four scientific groups driving the Program:

- Data Collection & Analysis: mapping and evaluating existing data across the industry, supported by a Memorandum of Understanding with RIFM.
- Analytical Profiling: commissioning advanced characterisation studies with academic experts to demonstrate the uniqueness of essential oils and natural plant extracts versus recomposed mixtures.
- Human Health Toxicology: reviewing available genotoxicity and related data for both whole oils and components, using non-animal methodologies due to regulatory constraints.
- Environmental Fate: examining biodegradation behaviour and environmental fate of whole essential oils versus isolated constituents, including via multi-partner initiatives such as the BioSinc project, which integrates data analysis, in silico modelling and laboratory testing.

A Call for Partnership

Dr Bonello concluded by outlining the significant financial requirements, projecting a budget of up to €3 million for the work programme through 2028, with an immediate need of approximately €1 million for the coming year. The success of the Program will require coordinated industry engagement to secure the future of essential oils in the EU and ensure that regulatory decisions reflect robust and relevant scientific evidence.

Support the EFEO-IFEAT Scientific Program
If you are interested in supporting the EFEO-IFEAT Scientific Program, please contact **sciprogram.funding@nove.eu**

Work hard, play hard

Some highlights from the Conference special events – scan the QR code to see the full Conference gallery!

IFEAT Dinner

The IFEAT Dinner, held at the beautiful World of Volvo venue, gave delegates the chance to experience the legendary Swedish brand's most iconic cars up-close, before an enchanting performance by a local youth choir, a gourmet buffet, and dancing into the night to the incredible party band Ploplabbet.

Young IFEATians 2: Around the World in Scents

Following the huge success of our first ever Young IFEATians event in Bangkok, Young IFEATians 2: Around the World in Scents saw teams work together in a lighthearted competition to identify different scent profiles from around the globe. The event space was packed to the rafters, and Young IFEATians co-leads Henry Gill and Sergio Davalos – with the support of volunteer team leaders from across the world – coordinated the capacity crowd with aplomb.

Closing Banquet

The Scandinavium Arena saw performances by a local dance troupe; famed vocal trio Solala and the world-renowned ABBA tribute act, Arrival – after all, we couldn't let a Conference in Göteborg go by without enjoying Sweden's best loved pop music export. DJ Inez capped the night off with a set that saw delegates celebrate the end of another unforgettable IFEAT Conference, as ever, on the dancefloor!

IFEAT 2025 Sustainability Awards

At the closing banquet of the IFEAT 2025 Conference, delegates witnessed the first ever IFEAT Sustainability Awards – a milestone that places sustainability at the heart of the F&F industry.

The IFEAT 2025 Sustainability Awards were launched in response to rising expectations from clients and regulators, the industry's deep dependence on natural resources, and growing scrutiny over sourcing practices and reliance on petrochemicals. By recognising initiatives that ecosystems, empower communities, and drive systemic change. For this first edition, the response was remarkable: 40 applications were received from IFEAT Members across Asia, Europe, Africa, and North America, a powerful signal that the call for sustainability is truly universal.

To ensure fairness and credibility, each project was first evaluated using a scoring framework developed by Quantis, a leading sustainability consulting firm. The assessment is built on four pillars: environmental impact, socio-economic benefits, scalability, and collaboration. This method allowed for a balanced comparison across very different types of initiatives. Awards were given in two categories – one for SMEs and one for large companies – and the top-scoring projects were then reviewed by an expert panel convened by IFEAT.

Insights and Trends

Beyond celebrating the winners, the first edition of the IFEAT Sustainability Awards offered a snapshot of the industry's sustainability journey.

Mint cultivation featured prominently as a testing ground for more resilient and inclusive farming models, while regenerative practices showed how degraded land can be restored for long-term benefits.

On the innovation side, bio-based chemistry emerged as a key theme, reducing reliance on petrochemicals - alongside eco-design and digital tools. While promising, these solutions also raised questions about accessibility and scalability, particularly for smaller enterprises.

As one Member of the expert panel noted, ranking the many innovative applications was "Complex and multifaceted – like solving a 54-facet Rubik's Cube." That complexity is a strength, showing that sustainability in our industry is advancing along multiple paths – farming, chemistry, and technology.

The Winners

Six projects stood out for their creativity, depth, and potential to drive systemic change. Let's explore these winning initiatives and see how they are redefining sustainable practices in our sector.

SME Category (<250 employees)

In Amroha, Uttar Pradesh, **Norex Flavours Private Limited** has pioneered regenerative mint practices across 100 villages. Recognised as the 1st prize winner in the SME category, its Project Sankalp demonstrates how science, inclusion, and collaboration can transform both landscapes and livelihoods. With over 2,500 smallholder farmers, the initiative integrates regenerative agriculture across ~1000 hectares, industrial efficiency, and social empowerment into a replicable model for rural prosperity.

At its core lies Early Mint Technology (EMT), developed in partnership with the Central Institute of Medicinal and Aromatic Plant (CIMAP). This innovation shortens crop cycles by 30–50 days, reduces water use by 25–30%, lowers energy demand, and enables faster soil recovery. Farmers now use vermicompost, cow manure, and neem-coated urea instead of synthetic inputs, alongside intercropping and stolon sowing. These practices have reduced chemical use by 70%, improving soil health and biodiversity. Ten distillation units were retrofitted with biomass-based fuels, water recirculation systems, cooling towers, and stainless-steel separators - reducing emissions, improving safety, and increasing oil recovery by 15–20%. Biomass residues are reused as biochar, enhancing soil fertility, water retention, and carbon sequestration.

The socio-economic gains are equally striking. Farmers' incomes have risen by about 50% – from 99,000/ha to 148,000/ha – through higher yields, intercropping, and direct farmer-to-buyer connections. Over 100 training sessions with CIMAP experts on Good Agricultural and Collection Practices supported widespread adoption. Women-led initiatives in mint cultivation now ensure equal wages and home-based enterprises, these groups also participate in literacy and WaSH (Water, Sanitation, Hygiene) programs that have improved health and living standards. Vulnerable groups have gained access to pensions and ration benefits. Upgraded distilleries offer safer work conditions with shaded rest zones, PPE (Personal Protective Equipment) kits, structured shifts – reinforcing dignity and compliance.

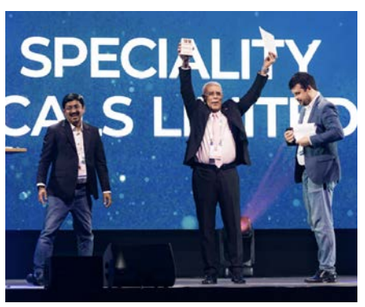
Scaling this impact has relied on digital innovation. A farm traceability app deployed across all farms captures real-time data on inputs, yields, water, and carbon. Certified under SAI-FSA standards and audited by Bureau Veritas, it ensures transparency and helps farmers adapt practices.

As Vaibhav Agrawal, MD & CEO of Norex, stated, "Sustainability is not a checkbox for us. It is a responsibility we embrace across our farming communities, supply chains, and innovations. This award strengthens our resolve to continue building a future where growth and responsibility go hand-in-hand."

Zalabí was awarded 2nd prize in the SME category for its Scalable Circular Model for Regenerative Oils in Water-Scarce Spain. The company has developed a 300-hectare regenerative model, certified EU organic, powered by 100% solar irrigation, biomass/solar distillation, and water recirculation. The project preserves biodiversity, minimises its carbon footprint well below industry averages and provides local farmers with training in sustainable practices. Generating stable jobs in the depopulated Guadix region, it demonstrates high ROI, resilience, and scalability.

Origin Oils received 3rd prize in the SME category for its Lemongrass on Fallow Land Project, which has converted 200 hectares of degraded land in Madhya Pradesh into productive lemongrass cultivation. In partnership with tribal farmers and local authorities, the initiative applies organic practices that restore soils, prevent erosion, and sequester up to 2,000 t CO_2 annually. Supported by the MNREGA Government Scheme, farmers received training at zero cost, guaranteed buyback, and stable income opportunities. The project demonstrates strong ROI, resilience, and potential for replication in other degraded regions.

Large Companies Category (>250 employees)



Privi Speciality Chemicals Limited, one of India's leading aroma ingredient producers, was awarded 1st prize in the Large Company category for its flagship initiative: Bio-based Innovation for Sustainable Aroma Ingredients.
The project converts Crude Sulphated Turpentine (CST) - a by-product of the pulp and paper industry often wasted or used in low-value applications - and Gum Turpentine Oil (GTO) – a renewable feedstock from sustainably managed pine plantations – into high-value aroma ingredients such as α-pinene, β-pinene, terpinene-4-ol, and paracymene. With a combined CST and GTO processing capacity of 36,000 and 9,600 metric tons per year, Privi's operations exemplify industrial circularity on a commercial scale.

By replacing fossil feedstocks with renewable inputs, this innovation aims to reduce dependence on petrochemicals and is expected to lower cradle-to-gate GHG emissions, though comparative results against conventional feedstocks are not yet quantified. The initiative integrates third-party verified Life Cycle Assessments (LCA) compliant with ISO 14040/44 for key products.

The project also reinforces socio-economic responsibility through certified sourcing, supplier audits, and a strict code of conduct. CST is derived from industrial waste while GTO suppliers are FSC- and RSPO-certified. More than 11,500 people have benefited from Privi's CSR programs, which include water conservation, education, and health initiatives.

Backed by dedicated R&D and process automation, Privi's initiative shows how, with targeted investment, technical guidance, and workforce training, established industrial systems can be adapted to integrate renewable inputs and support the wider adoption of bio-based chemistry.

Finally, its strength in collaboration lies in partnerships with CST pulp mills, GTO forestry communities, FMCG customers, NGOs, research institutions and industry dialogue through networks such as the Pine Chemical Association, CHEMEXCIL, IFRA etc.

As the company notes in its sustainability report, "Sustainability is not a choice, it is a commitment [...] industrial innovation and environmental stewardship can go hand-in-hand – delivering products that are smarter, safer, and more sustainable".

Mane Kancor earned 2nd prize in the Large Company category for its Sustainable and Traceable Mint Cultivation programme. By advancing Early Mint Technology, improved cooling towers, and upgraded distillation, the company achieved 37% less water use and 10–15% higher oil yields. Covering hundreds of hectares and engaging thousands of farmers, the programme combines training, certification, and fair pricing, increasing incomes by more than 80%. This scalable model delivers measurable environmental and social benefiat can be replicated for other crops.

DSM-Firmenich received 3rd prize in the Large Company category for its EcoScent Compass® Next Generation tool: a digital eco-design platform that applies global standards (ISO, LCA, PEF, IFRA) to deliver real-time sustainability scoring for fragrance design. Assessing impact across three key pillars: Circular design, Planet & Nature and Social Impact, the tool tracks metrics such as carbon footprint, renewability, biodegradability, upcycled content. Built on robust sustainability data, it is fully integrated into the perfumers' creation platform enabling data-driven design. To date, it has analyzed over 70,000 fragrance formulations and integrates more than 80 sustainability data points per ingredient. This long-term commitment positions eco-design as a key driver of innovation, transparency, and value across the fragrance industry.

This first edition showed the extraordinary creativity alive in our industry. While six projects stood out, every initiative contributes to a more sustainable future. In the words of the panel, this was "a contest with no losers".

Inside Borregaard:
How a Cascading Biorefinery Turns Norway Spruce into Sustainable Vanillin

Dr Peter Greenhalgh[1]

Executive Summary

At the end of IFEAT's Göteborg Conference some 55 delegates from 22 countries undertook a one-day visit to Borregaard's cutting-edge biorefinery in Sarpsborg, Norway. Key takeaways included:

- The plant's scale stretching over 3 km and annually processing 1 million m³ of Norway spruce (*Picea abies*).
- The cascading nature of the biorefinery operations utilising 94% of the raw material inputs to produce over 800 products with a diverse range of uses.
- Wood vanillin is one of the many products produced but faces competition from vanillin produced from other diverse raw materials.
- Sustainability is at the forefront of the company's operations but a complex topic.
- Continual innovation is being achieved by sizeable R&D investment leading to improved processing efficiencies, developing new uses, improving sustainability and reducing carbon footprint.

1. Introduction

On Friday 19 September 2025, at the end of IFEAT's Göteborg Conference, some 55 delegates from 22 countries travelled to Borregaard's cutting-edge biorefinery in Sarpsborg, Norway. Attendees were impressed by the scale of the Sarpsborg operations, spread over 3 km and the world's largest biorefinery, noted for producing sustainable bio-based vanillin from Norway spruce. The programme included an introductory presentation by Jørgen Fyhn Bjerkenes, which supplemented a Conference presentation earlier in the week on Cleantech Biovanillin by Martin Lersch. Then followed a viewing of the control centre and a coach tour of the large facility. The day concluded with lunch at the historic Borregaard Hovedgård – the secret site of the Oslo Accords negotiations – followed by group photos and the presentation of an IFEAT Certificate of Thanks to the Borregaard staff.

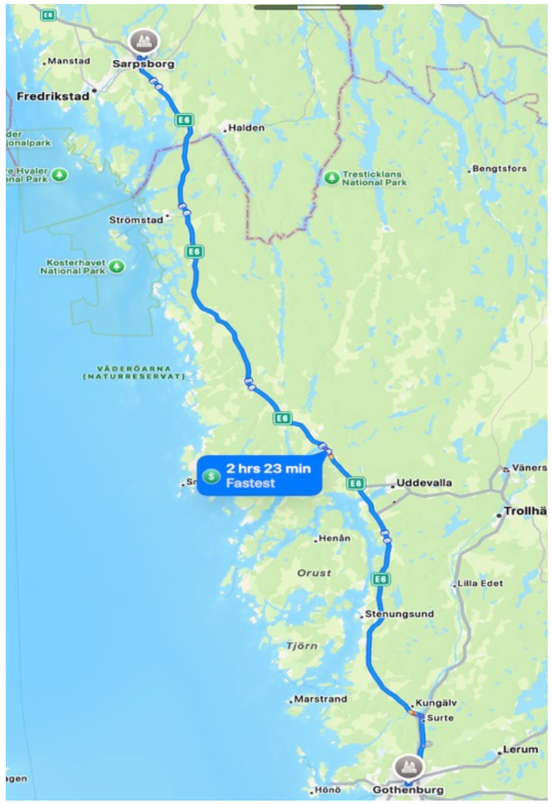


Figure 1: *Map of journey*

Borregaard was founded in 1889, initially focusing on pulp and paper, but later diversified into producing chemicals from wood. Its core business is now a biorefinery, manufacturing products such as speciality cellulose, cellulose fibrils, lignin-based biopolymers, bioethanol, biovanillin, and fine chemicals. The Sarpsborg biorefinery, built in 1889, is located by the River Glomma – Norway's longest and most voluminous – which was initially used to transport the logs. The plant also utilises the nearby waterfall, the second largest in Europe by volume, to generate hydro-electric power. The plant employs 880 people, while the company overall employs 1,150, many of whom are shareholders.

Figure 2: *Field trip participants and Borregaard staff*

Figure 3: *Field trip participants and presentation of certificate to Borregaard staff*

The following sections provide an overview of the Borregaard biorefinery followed by a discussion of vanillin sources and their relative carbon footprints.

Figure 4: *Borregaard Biorefinery in Sarpsborg, Norway*

Source: Borregaard

2. Biorefinery's Integrated Cascading Processing Operation

Biorefinery Fact Box

Site:
Sarpsborg, on the River Glomma (hydropower; integrated logistics).

Scale:
~1 million m³ spruce/year; over 800 products.

Process:
Cascading biorefinery (cellulose → sugars/ethanol → vanillin → lignin products).

People:
880 site, 1,150 company; slightly below 100 in R&D;
3 control centre teams with six-shift model.

Sustainability:
PEFC/FSC inputs; LCA <1 kg CO_2/kg vanillin (cradle-to-gate).

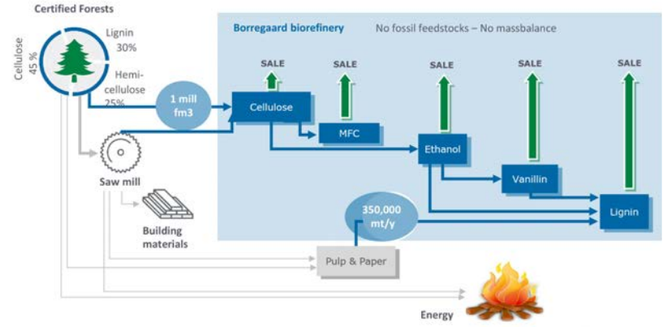


Figure 5: *Cascading use of wood in the forest industry*

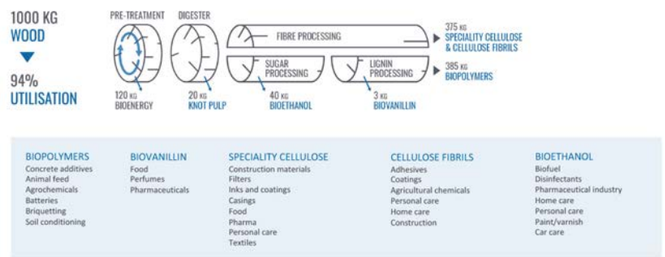


Figure 6: *Borregaard biorefinery integrated processing system and product uses*

The integrated cascading process is illustrated in **Figures 5** and **6**, both of which show the cascading use of the raw material input, namely Norway spruce. **Figure 5** shows the flow of timber from the certified forest either to the sawmill for timber or through various processes in the biorefinery to produce a range of products. **Figure 6** illustrates the proportion of products used from processing 1 MT of wood as well as the diverse end uses in which these products are used.

[1] IFEAT Consultant. The author would like to thank Jørgen Fyhn Bjerkenes, Tone Horval Bredal and Martin Lersch from Borregaard for comments and illustrations as well as IFEAT colleagues especially Alain Frix and Zahra Osman Guelle. He is responsible for any errors.

2.1 Raw Material

The most valuable part of the tree goes to the sawmill for use as timber, while the rest of the tree unsuitable for timber (tops and bottoms) goes to the biorefinery. No other type of wood is used in the biorefinery. Norway spruce is a relatively fast-growing evergreen conifer which can reach 40 metres and live up to 1,000 years. The trees processed at Sarpsborg are upwards of 70 years old and for every tree felled two new ones are planted. Spruce accounts for approximately half of Norway's forest, alongside pine and birch. The forest continues to grow at historic rates, having tripled over the past century, with the yearly increase more than 10x Borregaard's requirements. Raw material availability should never be a problem for the biorefinery. When a tree is felled, the prime cuts go to the sawmill. The wood unsuitable for the sawmill is transported by truck and rail to the biorefinery.

2.2 Biorefinery Processes

The processing operations are illustrated in **Figure 5**.

The first stage in processing the logs is the removal of bark in a debarking drum. Once debarked, the logs enter a highly efficient woodchipper with immense power that chops the large logs into chips within seconds.

The chips are then transported via a conveyor belt to the maturation silos, where impurities are broken down through the addition of heat and air.

After maturation, the chips move on to the digester. The matured chips are conveyed from the maturation silos to the digester, where they are mixed with cooking liquor.

The chips are digested at high temperature and pressure.

Figure 7: *Spruce wood piles prior to chipping*

Figure 8: *Spruce wood chips before processing*

When the digesting process is complete, the lignin (the binding agents) and the sugars in the wood are dissolved – leaving only the cellulose fibres in solid form. The lignin and sugars are then separated from the cellulose.

The cellulose is sent to the bleaching plant, while the liquid stream of binding agents and sugars continues to the ethanol plant.

At this facility, the sugar components of the wood are utilised. Yeast is added, and the sugars are fermented into advanced bioethanol.

After the sugars have been used in the ethanol plant, the lignin continues to the lignin plants, where it is purified and modified to obtain desired properties depending on its end use.

Some of the lignin can be used in the production of vanillin. The vanillin molecule occurs naturally in wood; it is the same molecule found in the vanilla orchid. Using high temperature and pressure, vanillin is extracted from the lignin.

In the microfibrillated cellulose plant the cellulose is split into a complex network of tiny cellulose fibres that improve flow properties, add strength, stability, and structure for a number of speciality cellulose applications.

The biorefinery has evolved over time and the biorefinery now processes approximately 1 million m^3 of Norway spruce each year from sustainable managed forests. In the early days the waste from the digester was seen as effluent and put in the nearby river. Over the past century the processing operations have continued to evolve as new products and processes have been developed. "Waste" from one plant becomes the raw material for the next, leading to the evolution of a fully integrated biorefinery. Initially the operations started recovering cellulose, then hemicellulose sugars were processed into sugars, then in 1962 the vanillin process was introduced, whereby the sulfonated lignin is subject to an oxidation process where the vanillin is formed. Further lignin-based products are also produced.

The biorefinery has changed during the last few decades partly to adapt to changes in the market as well as regulatory changes (e.g. restrictions on effluents). To take just one example, over the past six decades the company has developed a wide range of specially adapted varieties of vanillin for different applications. However, the raw material has not changed so that the ratio of the three main wood components, namely cellulose (45%), hemicellulose (25%) and lignin (40%), has remained constant.

2.3 Products and Yields

Figures 5 and **6** illustrate the production system, and the wide range of products produced, exceeding 800. Of the 1,000 kg of Norway spruce fed into the biorefinery, some 94% is processed into marketable products, namely:

- 385 kg of lignin-based biopolymers
- 375 kg of speciality cellulose and cellulose fibrils
- 120 kg bioenergy
- 40 kg of bioethanol
- 20 kg knot pulp
- 3 kg of biovanillin

Both vanillin and cellulose fibrils exemplify the cascading biorefinery – the continuous improvement in processes, sustainability, environmental impact, and product properties. Vanillin is discussed in detail in the next section, but cellulose fibrils is another very interesting new product with a range of applications including in the F&F industry. It is made up of millions of molecular fibrils which are broken apart, increasing the surface area and giving them a tremendous water holding capacity. Cellulose fibrils are widely used in personal care products because of their ability to control viscosity as well as having the ability to be sprayed. They can be used as a sustainable, high-performance alternative to petrochemical-based products.

2.4 Control Centre

Following the introductory presentation, we visited a viewing area where we were able to overlook a central area with several consoles controlling the whole biorefinery's operations. This control centre opened in 2010/11 following substantial investment to rationalise and automate the whole operations and centralise control over each of the separate plants. There are six teams of 30-35 people each working eight-hour shifts to monitor and operate the plant. There is a six-shift system with approximately 200 shift operators divided into shift teams. Four people were viewing the consoles while a further 30 field operators were available to check specific operations, take samples etc. Operators usually work two shifts in the control centre and four shifts in the field.

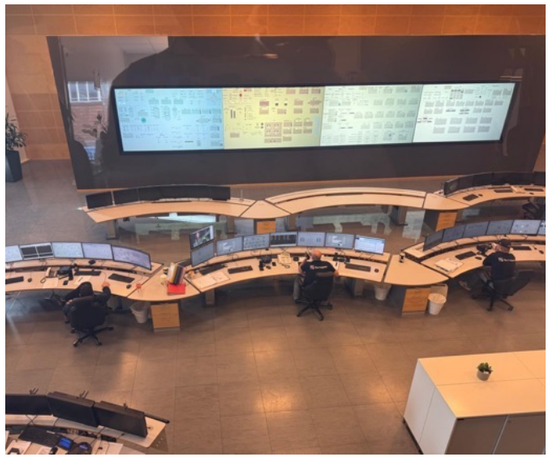


Figure 9: *Borregaard biorefinery control centre*

2.5 Research and Development

A key component of Borregaard's activities is R&D, as the company is continually innovating and developing new products and uses, while trying to lower its carbon footprint by improving its processes. Almost 100 people out of Borregaard's 1,100 total employees are working on R&D, with currently 32 having Ph.Ds. The remaining employees cover a range of activities including the biorefinery, fine chemical production and support functions. The company invests approximately 3% of its revenues in R&D and innovation. In 2024 some 14% of Borregaard's revenues came from new products.

3. Sustainability and Low Carbon Footprint

Sustainability is core to the entire Borregaard business model and is a fundamental component of its supply chain and products. This includes:

- Raw materials and products: using sustainable and certified wood meeting PEFC and FSC standards; lignin raw materials from certified or controlled forests and non-GMO raw material.
- Processes incorporating reduced emissions and improved LCA, energy conservation, green energy sources, reduced water and air emissions.
- Products with added sustainability value to customers and favourable GHG footprint, bio-based natural raw materials and non-toxic harmless products.

The world's most advanced biorefinery is producing many products in a cascading process, where 94.3% of the incoming wood is leaving the gates as sustainable bio-based products for industrial markets. Using only certified wood and hydropower, the LCA (Life Cycle Assessment) for these products shows a very favourable environmental footprint. For example, its vanillin has a carbon footprint well below 1 kg CO_2 per kg and this is discussed in more detail in the next section. In 2024 total energy consumption was 1,859 GWh of which 66% was renewable.

The company maintains a series of ambitious targets to lower GHG emissions. The target for 2030 is a 42% reduction within Scope 1 and 2. The company's SBTi approved plan for net zero by 2050 will further improve the environmental status of its products over the coming decades.

The company has been awarded for its efforts and has been recognised as a global leader in corporate climate action as well as achieving EcoVadis gold status and being in the top 5% of 115,000 reporting companies.

4. Vanillin and Vanilla

4.1 Vanilla

Vanilla is recognised as one of the world's favourite flavouring ingredients. It has a wide range of uses, which can be divided into two distinct areas, namely in food and flavour applications and the fragrance/cosmetics/personal care/home care industries. An estimated 18,000 products worldwide contain vanilla flavour, and it is available in a variety of forms both natural and synthetic.

Vanilla is one of the most complex of flavouring ingredients, not only in terms of growing and processing but also considering its complex flavour profile, with over 400 flavour compounds being detected. However, the compound vanillin (4-hydroxy-3-methoxybenzaldehyde) is the one primarily responsible for the characteristic flavour and smell of vanilla. Another minor component of vanilla is piperonal (heliotropin), which along with other substances affects the odour of natural vanilla.

Plant-based vanillin is produced from vanilla orchids, wood, rice or clove. Oil-based vanillin is derived from guaiacol made from crude oil. The high cost and scarcity of natural vanilla from the orchid *Vanilla planifolia* led to the first commercial production of vanillin molecules over 100 years ago from other natural sources. Production of synthetic vanillin from petroleum started more recently in the 1980s.

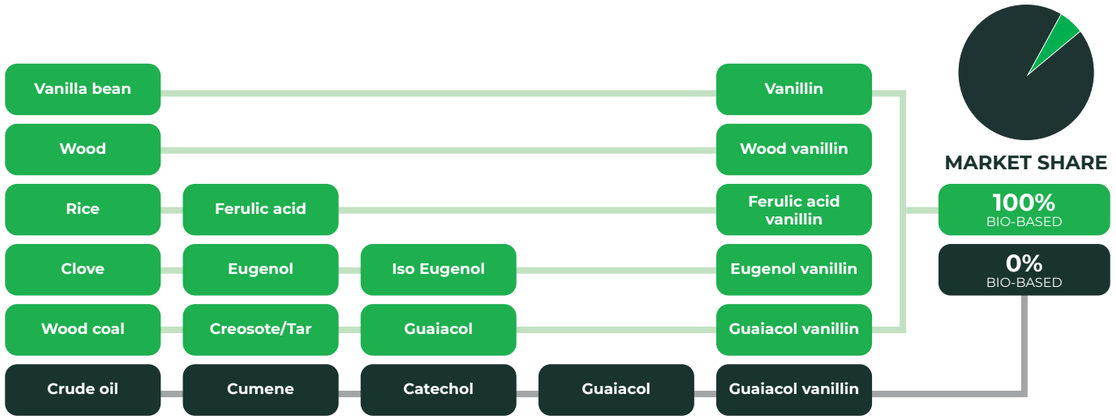


Figure 10: *Vanillin sources and market shares*
Source: Borregaard

4.2 Sources of Vanillin and Market Shares

There are several sources of vanillin, illustrated in **Figure 10**.

1. Vanillin is a component of natural vanilla obtained from the orchid *Vanilla planifolia*. Annual production of natural vanilla ranges between 2–3,000 MT. Vanillin constitutes around 2% of the dried weight of the cured vanilla beans (i.e. 40-60 MT pure vanillin). Vanilla beans provide less than 1% of the vanilla aroma used in flavours and fragrances. Annual output of natural vanilla beans is quite volatile because of climatic factors as well as political and speculative activities, each of which can severely influence prices and availability.

2. Vanillin from wood – Borregaard is the only supplier producing vanillin from wood, namely the Norway spruce (*Picea abies*) which is a natural and renewable raw material. This vanillin is sustainable and the only PEFC certified vanillin on the market. Annual production is of the order of 1,500 MT. Borregaard offers a range of vanillin products including pure vanillin blended with a carrier.

Figure 11: *Box of Borregaard vanillin crystals 25 kg*
Source: Borregaard

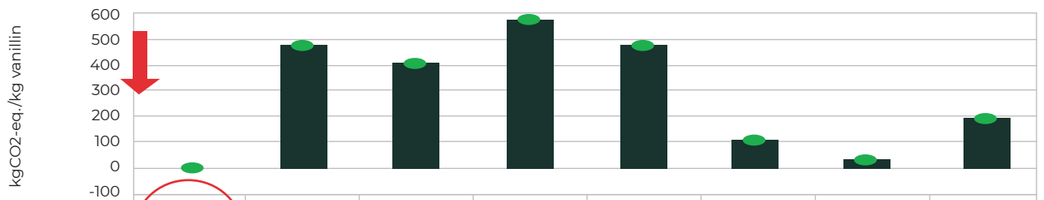
3. Vanillin from other plant materials including:

(a) From eugenol extracted from cloves, predominantly from Indonesia but also China and India, with production estimated at around 800 MT/year.
(b) From ferulic acid extracted from rice bran/straw, through microbial fermentation converting ferulic acid into vanillin through a series of enzymatic reactions. Rice bran is a waste product. Production is a few hundred tonnes per year and is undertaken in China and Europe. This vanillin is considered EU natural by much of the market.
(c) From wood coal to creosote/tar to guaiacol vanillin.
(d) From sugar through synthetic biology to engineer yeast strains converting sugar (glucose) into vanillin through a fermentation process. Annual production is under 100 MT.
(e) From turmeric but only small quantities predominantly from India.

A variety of processes is used and the total volume of vanillin from other plant materials including wood is estimated at approximately 2,300 MT.

4. Crude oil can be converted to vanillin and ethyl vanillin by a purely synthetic process starting from guaiacol and guethol respectively. Currently this source dominates vanillin production with annual output for each item estimated at 19,000 MT and 6,000 MT respectively. China is the dominant producer with annual production exceeding 15,000 MT, with an estimated 80% going to flavours and 20% to fragrances and speciality polymers. The USA, France and India are also producers.

Vanilla bean accounts for approximately 0.5% of vanilla flavourings consumption worldwide, with around 88% from synthetic vanillin derived from a petrochemical base and approximately 11.5% is from bio-based material. Borregaard is by far the largest manufacturer of the latter, supplying approximately 1,500 MT per year of vanillin. The fragrance industry mainly uses synthetic vanillin while food producers purchase most natural vanilla volume. To fill the gap between demand and supply, food producers also search for naturally produced vanilla flavours. While the vanillin from all the above sources is the same molecule there are substantial differences in the flavour intensity.



	Borreggard's biovanillin produced in Norway	Competing eugenol-vanillin produced in China, with eugenol extracted via hydrodistillation technique	Competing eugenol-vanillin produced in China, with eugenol extracted via MAE technique	Competing eugenol-vanillin produced in Indonesia, with eugenol extracted via hydrodistillation technique	Competing eugenol-vanillin produced in Indonesia, with eugenol extracted via MAE technique	Competing guaiacol-vanillin produced in USA	Competing guaiacol-vanillin produced in France	Competing guaiacol-vanillin produced in China
GWP-LULUC	0.01	0.28	0.25	0.79	0.64	0.06	0.02	0.08
GWP-biogenic	-1.02	-4.37	-3.49	0.82	0.54	0.53	0.44	-0.94
GWP-fossil	0.69	475.77	401.29	571.86	475.80	108.20	32.27	197.20
GWP-Total	-0.33	471.68	398.05	573.47	476.98	108.79	32.73	196.34

*) MAE – Microwave assisted extraction
Figure above taken from **https://norsus.no/publikasjon/environmental-analysis-of-competing-products-for-biovanillin-from-borregaard/**

The full Environmental Product Datasheet (EDP) for Borregaard's EuroVanillin Supreme is available from EPD Norway
https://epd-global.no/getfile.php/13162785-174162983/EPDer/Kjemilalier/NEPD-2972-1657 Vanillin.pdf

Figure 12: *Vanillin sources and market shares*

4.3 Vanillin Sustainability and Carbon Footprint

There is increasing consumer demand for products formulated with ingredients of natural origin and a minimal environmental footprint. Borregaard's vanillin is 100% biobased and characterised by high purity. The product is suitable for use in food applications; however, it is not classified as "natural" under the regulatory definitions applied in all jurisdictions.

The classification of vanillin as "natural" varies depending on both the production process and the applicable regulatory framework. For example, vanillin derived from clove is considered natural in the United States but not in Europe. Vanillin obtained from rice is recognised as natural in both regions. Biotechnologically produced vanillin from glucose is regarded as natural by some market participants, although this interpretation is not universally accepted.

Just as "natural" is a complex topic in the F&F industry, so is the measurement of "sustainability' and "carbon footprint" (Frix 2025). For the past two decades Borregaard has been undertaking LCA - Life Cycle Analysis – to assess the sustainability of its products, including vanillin, using a third-party company. Also, studies were undertaken to try to assess the CO_2 footprint of other vanillin producing operations. While techniques of measuring may differ slightly, the main conclusions are the same. A summary of one set of findings is summarised in **Figure 12**, which shows the carbon footprint of eight different processes to manufacture vanillin. The CO_2 footprint of Borregaard vanillin is below 1 kg per kg of product, which is 20-29 times lower than the vanillin from fossil fuels.

Borregaard's plant-based vanillin is based on 100% renewable carbon. It provides a 90% reduction of CO_2 footprint. The most influencing parameter on the CO_2 footprint is the energy source and processing chemicals. Biobased feedstocks receive a small deduction. The LULUC (land use and land-use change) is also a minor contributor compared to the energy impact.

IFEAT and the participants would like to thank the Borregaard company and staff for opening their Sarpsborg operations and providing information on their complex operations as well as providing the figures for this article.

List of Abbreviations

FSC	**Forest Stewardship Council**
GHG	**Greenhouse Gas**
GMO	**Genetically Modified Organism**
GWh	**Gigawatt Hour**
LCA	**Life Cycle Assessment**
LULUC	**Land Use and Land-use Change**
m^3	**Cubic Metre**
MT	**Metric Tonne**
PEFC	**Programme for the Endorsement of the Forest Certification**
R&D	**Research and development**
SBTi	**Science Based Targets initiative**

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My Favourite: Sandalwood

by **Agnes Gendry-Hearn**

Agnes Gendry-Hearn shares her globe-trotting quest, from India's forests to innovative community projects, to secure the future of the deeply loved, yet endangered, sandalwood.

***Agnes Gendry-Hearn** is the newest Member of IFEAT's Executive Committee, having joined the Committee in September 2025. She works as Head of Essential Oils Purchasing for Lush Ltd.*

I have always loved *Santalum album*, with its deep, creamy note, both sensual and comforting; most of my favourite perfumes are sandalwood-based. As a consumer, before I had any involvement with the perfumery industry, I had little awareness or knowledge of this amazing material beyond the fact that it traditionally came from India, where it had been used for many generations. I had no idea of the difficulty of propagating it, of its low rate of survival when replanted or its slow growth once established. And I did not know there were different species, each with its own character – and each endangered to some extent.

However, this changed twenty years ago, when, as a new essential oils buyer for Lush Cosmetics, sandalwood became my first deep dive into positive sourcing and my introduction to the concept of regeneration rather than sustainability. At the time, we only used *Santalum album* from India, but my horizons quickly expanded and my sandalwood journey ultimately became a globe-trotting exploration spanning many years, in search of ethically managed sources of the different types of this wonderful material.

In the heart of the Indian subcontinent, the lush valleys of Mysore cradled a legacy rich in history and culture, all centred around a single, aromatic tree: the sandalwood. Renowned for its fragrant heartwood, sandalwood had captivated civilizations for centuries, woven into rituals, art, and commerce. For centuries, sandalwood trees were revered by local communities, seen as sacred gifts from nature. Their timber was utilised to carve intricate sculptures of deities, which adorned temples, reflecting the spirituality ingrained in the region's culture. The rich scent of sandalwood was believed to purify the air and soothe the soul, making

Sandalwood is an essential element in religious ceremonies and meditation practices.

it an essential element in religious ceremonies and meditation practices. Sandalwood's significance extended far beyond India's borders. Traders brought the precious wood to distant lands, exchanging it for silk, spices, and other commodities, thus initiating a dialogue between cultures. From the bustling markets of ancient Rome to the palaces of China, sandalwood symbolized luxury and status. However, over time, as its popularity surged, so did the pressures on its natural habitat. With the rise in demand, the sandalwood tree faced the relentless threat of overexploitation. The great forests that once flourished began to dwindle as illegal logging took its toll. The once-bustling trade routes, which had enriched many, became avenues for rampant deforestation.

In the 19th century, the use of sandalwood oil also transitioned from traditional uses to becoming a prized staple material in the rapidly growing European perfumery industry, valued for its beautiful long-lasting scent and fixative properties in perfume compositions. This growth in popularity contributed to worsening the overexploitation of the tree stocks and accelerated the near disappearance of sandalwood in many parts of India. Although the Indian Government set standards and yearly quotas for harvesting sandalwood trees through its Agmark, administered by the Directorate of Marketing and Inspection (DMI), this seemed to have little effect on illegal logging and smuggling.

Rather than relying on a single, unclear and hard-to-trace dwindling source, I made contact with individuals and companies which were similarly interested in finding long-lasting solutions. My sandalwood forays took me to India, Goa, Kanaky (New Caledonia), Tanna Island in Vanuatu, Australia and Hawaii. I learnt to pack light and expect the unexpected. I encountered the good, the bad and the downright ugly – the creeping illegal trade and export of red sandalwood (*Pterocarpus santalinus*) from Tanzania, for instance, which is now leading to population decline and potential extinction in another part of the world. But along the way, I also found honest, genuinely caring and forward-thinking producers and environmentalists passionate about reversing the damage done. Individuals not absorbed in the elegiac past but with their eyes on what the future of sandalwood could be and needed to be.

Through what I observed on my travels, I have concluded that large-scale plantations are not the way to go, as the need for purchasing or leasing land, as well as the slow growth of the trees, makes these plantations hugely onerous and the return on the large investment required uncertain. I strongly believe that sandalwood reforestation in its natural habitat, working with local communities, has far more potential to allow the regeneration of sandalwood populations.

There are many challenges to resolving the sandalwood crisis; however, there are strategies which could be implemented to promote sustainability in sandalwood cultivation and usage:

- **Strengthening Regulations:** Governments need to enforce stricter regulations against illegal logging and trade. This includes stronger penalties for poaching and better monitoring of sandalwood populations.

- **Community Engagement:** Involving local communities in conservation efforts is crucial. Education and awareness programmes can help them understand the long-term benefits of sustainable practices. Empowering locals through training in sustainable cultivation methods can create economic alternatives to logging.

- **Sustainable Cultivation Practices:** Researching and promoting agroforestry techniques where sandalwood is grown alongside other crops can provide farmers/smallholders with income while preserving the trees. Establishing sandalwood replanting in loco could offer a legal and sustainable source of income.

- **Certification:** Setting up certification programmes for sustainably sourced sandalwood can help consumers make informed choices while also providing incentives for ethical harvesting practices and can ensure that local communities benefit from sandalwood conservation.

- **Reforestation Programmes:** Initiatives to replant sandalwood trees in their native habitats can help restore ecosystems and improve biodiversity. Collaborations with NGOs and governments to fund reforestation can generate public interest and support.

- **Research and Development:** Continued research into the biological and ecological needs of sandalwood is essential. Understanding its growth patterns, environmental requirements, and pest management can help cultivate healthy populations for future generations.

Over the last four years, I have been involved in a replanting programme in West Timor, which functions on the principles above. It has required only limited financial investment, offers training for the local communities, is supported by the local government and a local NGO and fosters full agency and responsibility for all involved. The results so far are encouraging and can hopefully be used as a template for other regions.

Potentially losing such a beautiful, classic and time-honoured material or seeing it replaced by synthetic compositions is unconscionable and, in my opinion (an opinion shared by many of my perfumer friends), would be a blow to fine perfumery and not something I would wish to contribute to.

A multifaceted approach involving stricter regulations, community engagement, and innovative cultivation practices can pave the way for a balanced coexistence between our industry and the environment. By valuing sandalwood not just for its market price, but as a precious cultural and ecological resource, work can be done toward a future where sandalwood can thrive, not just survive. As a lover of sandalwood, I look forward to being part of this work.

Reforestation in natural habitats, working with local communities, is key to the regeneration of the world's endangered sandalwood populations.

The Scent and Taste of Carbon:

Balancing Growth and Sustainability in the F&F Industry

By Alain Frix, Allchemix Consultancy

Alain Frix

Although the Fragrances & Flavours (F&F) industry represents less than 0.04% of global GDP[1], valued at approximately $40 billion[2], it plays a significant role in our daily lives. However, growing concerns about its sustainability persist. Petrochemicals continue to dominate the sector, particularly with production now concentrated in Asia. While this shift has reduced costs and expanded market demand, the industry's overall sustainability performance – across environmental, social, and economic dimensions – has seen little improvement.

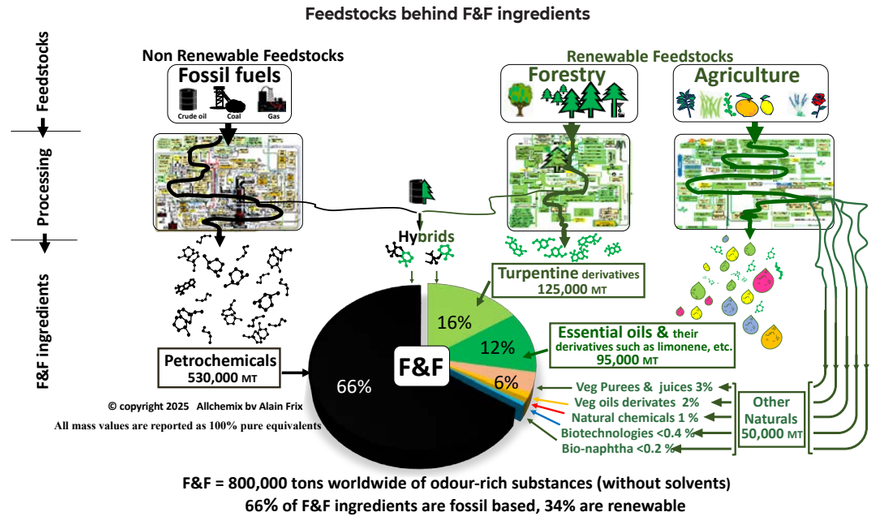

Figure 1: *The scents we cherish and the flavours we enjoy stem from thousands of ingredients, split into four main clusters.*

Source: Allchemix Consultancy

Industry context

Perfumery and flavouring compounds enhance a wide range of consumer products – from personal care to food – playing a subtle but vital role in how people perceive and enjoy their surroundings.

They are all made from F&F ingredients which can be categorised into four primary feedstock groups: petrochemicals, turpentine derivatives, essential oils, and other natural sources. These form supply chains that yield over 3,000 olfactory-rich ingredients, with a global annual mass near 800,000 metric tonnes (MT), excluding solvents [3] (**Figure 1**):

- **Petrochemicals (~530,000 t/year):** due to their cost-effectiveness and chemical diversity these non-renewable, fossil fuel-derived, synthetic ingredients dominate – accounting for around 2/3 of F&F ingredients. They offer creative freedom, key to developing olfactory molecules such as vanillin, hexyl cinnamic aldehyde, Hedione®, linalool, phenylethyl alcohol, etc.
- **Turpentine derivatives (~125,000 t/year):** these renewable materials are derived from by-products of the softwood forestry industry, whose primary products are cellulose and pine resins. They are often chemically modified and therefore classified as synthetic. Often somewhat more expensive than petrochemicals, various turpentine derivatives are crucial for perfumery, such as dihydromyrcenol and Iso E Super®.
- **Essential oils and extracts (~95,000 t/year):** mainly of agricultural origin (with some forestry contributions), these natural, renewable substances are sourced in over 300 plant species. More expensive than turpentine derivatives, they are of major socio-economic importance, especially for rural communities. Examples include essential oils from orange, lemon, mint, eucalyptus, lavender, lavandin, and rose, as well as natural extracts obtained from these biomasses, such as d-limonene (orange), L-menthol (cornmint), eucalyptol (eucalyptus), eugenol (clove), and anethole (anise, fennel). Essential oils remain the industry's main source of natural ingredients.
- **Other natural ingredients (~50,000 t/year):** this diverse category includes fruit juices, vegetable purees, various plant extracts, along with contributions from biotech and emerging, marginal processes, such as biogas – the latter often being used for carbon credit schemes rather than physically integrated into production chains.

Petrochemicals dominate the sector

The largest feedstock to F&F industry is petrochemical derivatives, accounting for more than 2,000 aromatic molecules[3][4](**Figure 2**). All of these materials originate from fossil fuels, which, according to the International Energy Agency, supply approximately 80% of the world's energy.[5] Despite the rapid growth of renewable energy in Asia, fossil fuel consumption reached a record high in 2023, driven by strong Asian energy demand[6], with petrochemicals expected to become the main driver of this demand in the long term[7][8].

Despite this dependence, recycling rates for petrochemical products, i.e. thermoplastics, remain very low[9], hampered by higher production costs for recycled versions than for virgin products from fossil sources[10].

This situation is concerning because fossil fuel reserves are limited: at current consumption rates, crude oil could be exhausted within 50 years, natural gas and coal within 100 and 140 years.

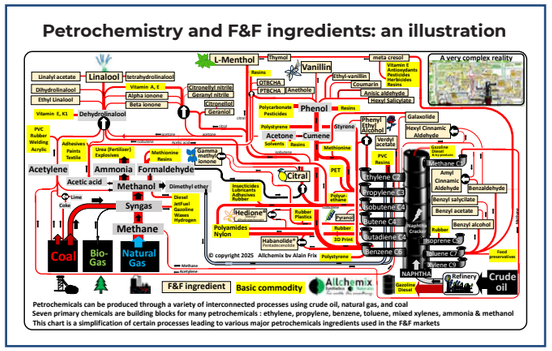

Figure 2: *This chart is a simplification of certain processes leading to various major petrochemical ingredients used in the F&F markets.*

Source: Allchemix Consultancy

Driven by cost, petrochemicals steadily replace naturals

Global production of Essential Oils (~300,000 MT in total, mainly for F&F, Resins, Camphor, and Solvents) is minuscule when compared to global production of Petrochemicals (~400 million MT for plastics, >750 million MT cumulative fossil carbon for consumer goods)[4].

Essential oils are more than mere ingredients – they are economic lifelines. The socio-economic contribution of natural F&F feedstocks is far larger than their global volume might suggest. They provide employment, enable rural development, and support gender equity in agricultural communities. This human footprint is a critical pillar of sustainability – one often neglected when sustainability is measured solely via carbon metrics.

The price gap between natural ingredients and petrochemicals has widened considerably in the last 30 years. A good example is illustrated by three notable raw materials used by the F&F industry: naphtha (derived from crude oil), turpentine (a by-product of the forestry industry), and D-limonene (a natural extract from orange peels). The price gap between these raw materials has widened considerably since the 2008 financial crisis, with naphtha remaining the most cost-effective option over the last 30 years.

This variance has steered investments toward fossil-based F&F ingredients, while driving down the share of natural ingredients – mainly in cost-sensitive markets such as Asia.

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 mainly extracted from *Mentha arvensis* oil (cornmint oil), whose global production exceeded 50,000 t 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 t[17], while BASF AG plans to increase its production of citral to 118,000 t by 2026[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 care segment has shifted from a predominantly natural L-Menthol to a predominance of fossil-derived L-Menthol, bringing significant negative socio-economic consequences.

Over the last 3 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. This cost-saving strategy only works if we ignore the hidden environmental cost of using fossil fuel derivatives, which will ultimately become a severe problem for future generations (**Figure 3**).

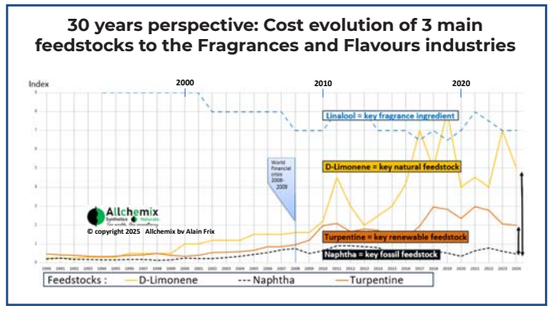

Figure 3: *Naphtha, a key derivative of crude oil, has consistently been the cheapest feedstock for more than three decades.*

Source: Allchemix Consultancy

Delocalisation of industry from the West to Asia

The relocation of production sites to Asia – to China and India for F&F, since the 1990s – is mainly driven by cost factors including those associated with regulatory pressure. Thirty years ago, Asia was seen as a promising consumer market for Western producers, overconfident in their industrial dominance since colonial times.

The shift in F&F ingredient production was largely driven by the closure of several aroma chemical plants, including a large one in the Netherlands in the mid-1990s, which made skilled staff and equipment available to Asian investors. The relocation of the multinational's machinery to China followed a pattern similar to that seen in the textile industry. Stricter environmental regulations in Western countries, in particular the EU's introduction of ambitious regulatory policies in the 2000s, although well-intentioned, ironically accelerated this relocation. Western-based companies outsourced their operations, starting with the most hazardous and waste-generating processes, eventually expanding this transfer to include a range of manufacturing activities.

Today, through advanced technology, massive production capacity and a skilled workforce, Asia has established itself as an independent and new global chemicals' hub (**Figure 4**). For some specific petrochemical ingredients, the global market's dependence on China exceeds 90%. China has achieved undisputed supremacy in chemistry – a feat that deserves great respect but also the fear of imbalance. Its dominance is no longer limited to production; it now spearheads innovation, advancing at a rapid pace. Asia will probably lead the next generation of sustainable F&F solutions, especially as it begins to transition away from coal, though it still depends on it heavily.

As illustrated by Ronald Piech in his historical account of fragrance chemistry in Germany[19], the fragrance industry has always been intrinsically linked to the chemicals sector. The ongoing shift of chemical production from West to East is expected to move the centre of gravity for fragrance ingredients 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 fragrances in the coming decades, in particular for personal care and household products.

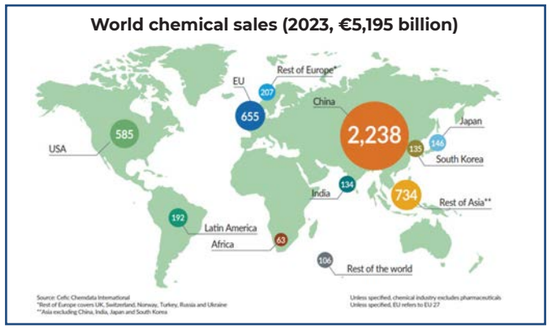

Figure 4: *Global sales of chemicals in 2023: Asia firmly established itself as the epicentre of global chemicals production*

Source: Competitiveness of the European Chemical Industry, a joint study by Cefic – Advancy.

The darker side of F&F

While profitable for the compounder, this shift to Asian chemicals production challenges sustainability goals and is generally associated with much higher greenhouse gas (GHG) emissions for three main reasons. Firstly, energy: the Asian industry relies heavily on coal – the main energy source in China, India, Indonesia, Vietnam, and many Southeast Asian countries. According to the International Energy Agency, new coal mines open every year[20] and global demand is expected to reach record levels in 2024[21]. This comes despite Asia making massive investments in green energy – the largest in the world – which still are not enough to meet the growing electricity demand. In 2023, at 15.7 Gt[7], coal was the prime contributor to global carbon dioxide (CO_2) emissions.

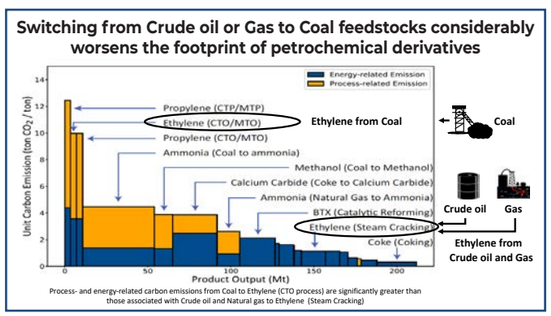

Figure 5: *Within petrochemicals, energy-related and process-related emissions differ fundamentally depending on feedstocks. Petrochemicals made from coal have a significantly higher GHG emission profile versus those made from crude oil and gas.*

Source: Tracing fossil-based plastics, Chemicals and Fertilizers production in China, Nature Communications, 08 May 2024

Secondly, in various manufacturing processes coal is the main raw material. For instance, converting coal into key chemical compounds such as methanol, and then into propylene or ethylene using Methanol-to-Olefins (MTO) technology, generates significantly higher GHG emissions than when producing the same chemical molecules from crude oil or natural gas via steam cracking, the method generally preferred in Western countries[22][23] (see **Figure 5**).

Thirdly, transport is another key factor in GHG emissions[24], due to western markets remaining the largest consumers, with considerable distances travelled.

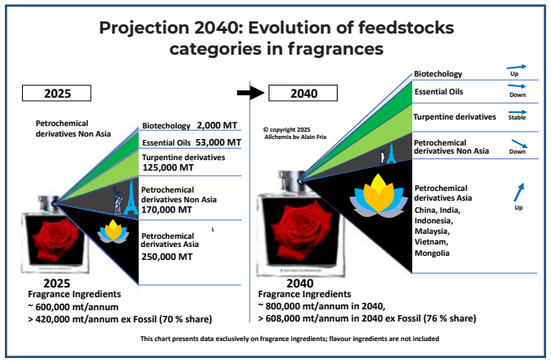

Figure 6: *Petrochemical ingredients will increasingly dominate perfumery and are primary produced in Asia.*

Source: Allchemix Consultancy

Rise of petrochemicals in fragrances: projection 2040

Cost sensitivity and standardisation dominates the fragrance industry, and petrochemical-based fragrance ingredients are expected to grow much faster than natural alternatives. A typical 3% annual volume growth in fragrance ingredients will be driven almost entirely by growth in petrochemical ingredients, whose market share is expected to rise from 70% to 76% by 2040 (see **Figure 6**). This rapid expansion of fossil-based ingredients underscores the urgent need to audit them properly.

Behind the green curtain of carbon footprint

There is only one way to measure the real impact of an industry on our environment: a comprehensive Life Cycle Assessment, which goes from how it originated to the very end, and which is not restricted to its Carbon Footprint.

A schematisation of Life Cycle can be split into eight steps, and each with unique and diverse sustainability impacts (**Figure 7**).

Steps 1, 2, and 3 generate the greatest environmental impacts, whether from renewable or fossil resources. They correspond to the primary transformation of the Earth's resources, are highly energy-intensive, and emit significant quantities of GHG. For biomass, this includes agronomic transformations – land acquisition and preparation, ploughing, harvesting, etc. For fossil fuel activities, this includes land preparation, infrastructure, drilling, extraction, vaporisation, fuel separation in refineries, and heavy chemical transformations. Significant GHG emissions come from methane leaks at coal and gas extraction sites: gas flaring, up 5% in 2023, emits over 300 million tonnes of CO_2-equivalent annually[31], an amount comparable to the United Kingdom's total annual emissions. UN reports for 2024 attribute 11% of global GHG emissions to farming and 10% to fossil fuel extraction and processing, highlighting their major climate impact[24].

Step 4 (rectification and fine chemistry) generally has a lower environmental impact due to advances in green chemistry that reduce energy consumption.

Steps 5 and 6 (formulation and incorporation into finished products) primarily involve blending operations that contribute little in the way of additional environmental impact.

Finally, steps 7 and 8 (waste and breakdown) are both complex and critical: the environmental impact of carbon molecules released during the breakdown of fragrances and flavours is highly scrutinized. Many renewable and fossil derivatives face scrutiny, particularly those used in large quantities. Reliable LCAs require a detailed, independent audit of agricultural fields and fossil extraction sites in order to verify the data.

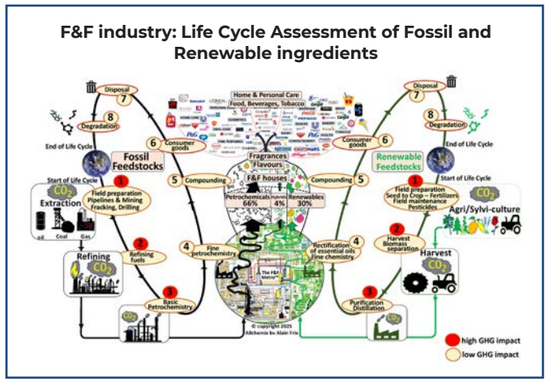

Figure 7: *Identification of the eight main stages in the lifecycle assessment of F&F products.*

Source: Allchemix Consultancy

With the exception of certain essential oils produced specifically for the fragrance and flavour (F&F) industry, most F&F feedstocks originate as co-products from other industries. Consequently, the primary production processes (steps 1 and 2 in Figure 7) for these raw materials are not tailored to F&F demand, which heightens the risk of supply chain disruptions within the sector. Figure 8 presents a schematic overview of the main F&F feedstocks.

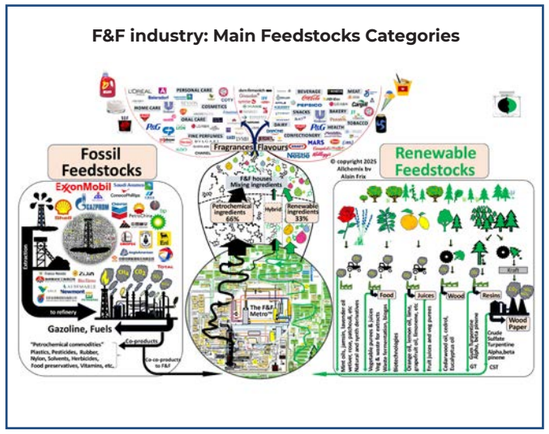

Figure 8: *Major feedstock categories supplied to F&F*

Source: Allchemix Consultancy

Audits on petrochemicals vs audits on naturals

Initiatives such as Together for Sustainability (TfS) and the Oil & Gas Climate Initiative (OGCI) seek to improve the transparency and traceability of fossil fuel emissions, yet, many fuel producers are reluctant to provide full data.

Most fossil fuel extraction sites are controlled by just a few energy giants such as China Coal, Gazprom, ExxonMobil, Saudi Aramco, Total, Coal India, most of whom have failed to set credible emission reduction targets via the Science-Based Targets (SBTi) initiative, settling for carbon neutrality commitments, which are deemed insufficient.

While the F&F industry promotes corporate social responsibility (CSR) in the natural ingredients sector – often demanding thorough audits at the farm level – this same level of scrutiny is seldom applied to fossil-based ingredients. The F&F industry may frequently overlook the wellbeing of workers and communities around coal mines, hydraulic fracturing or other extraction sites, often exposed to heavy environmental and health risks.

This gap between CSR requirements for natural products and the opaque practices of the fossil fuel sector calls for the establishment of unified ethical sourcing standards.

Also, certain petrochemical companies – chiefly those involved in fossil fuel refining or downstream production – simultaneously manage ranges of commodities, such as plastics or pesticides, and specialties. As such, it is vital to understand how the carbon footprint is internally allocated between these various segments. An advantageous breakdown could artificially reduce the apparent carbon impact of products destined for markets sensitive to sustainability issues, such as ingredients used in cosmetics, fragrances and flavourings.

The creation of an independent inspection body, such as a yet-to-be-born "Union of Ethical Petrotrade (UEPT)", would improve upstream transparency, guarantee workers' rights, protect the environment and more rigorously monitor emissions allocation practices in the petrochemical value chain.

The carbon footprint: valuable, though incomplete

The most widely used sustainability indicator to date reflects only a limited part of the overall picture. Focusing solely on the carbon footprint obscures key issues such as toxic waste pollution, drinking water conservation, or the socio-economic impact on more than four billion people living in rural areas. Certain companies, whether operating in petrochemical or renewable sectors, may achieve strong carbon footprint scores while still emitting significant quantities of toxic substances into the environment.

Correct measurement of a product's sustainable impact requires adopting a clear and comprehensive approach, capable of capturing the actual differences linked to the production methods and raw materials used to manufacture a given molecule. For example, the sustainability profile of vanillin varies greatly depending on its source: natural vanilla beans, lignin, clove oil, ferulic acid fermentation, sugar-based fermentation, turmeric, Chinese petrochemicals or Western petrochemicals.

The absence of a standardised protocol for sustainability indicators in the F&F industry reflects a lack of sectoral desire for harmonisation, highlighting the effort still required to move from partial transparency to true alignment.

Unveiling the F&F Underground: The F&F Metro™

The world of F&F ingredients can be compared to a vast subway system, where each station represents a chemical. 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 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 ten.

At this stage, it becomes possible to assess whether the transformation steps involve ecotoxic catalysts, halogenation reactions, or other environmentally harsh processes – even when the overall carbon footprint appears low. The nature of these chemical transformations varies considerably, particularly in processes involving petrochemical and turpentine-derived pathways. By contrast, the production of essential oils is more linear, relying primarily on distillation rather than extensive chemical modification and complex molecular synthesis (see **Figure 9**: "The F&F Metro™").

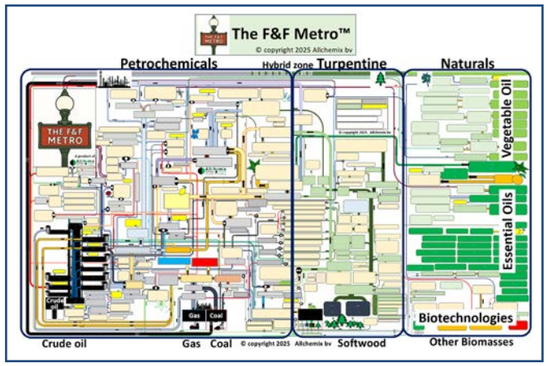

Figure 9: *The F&F Metro map: mapping production steps and interactions between feedstocks.*

Source: Allchemix Consultancy

Few leaders driving sustainable design

Due to concerns over safety and environmental impacts, the EU is applying ever more stringent regulations to the F&F sector that limit the use of conventional high-volume ingredients, such as butylphenyl methylpropional (known as Lilial®, Lilestralis®, Lysmeral®). These large molecules, often found in soaps and detergents, end up in wastewater. The challenge is to design components that are truly biodegradable, yet stable enough to be effective in formulations. The solution is to use highly powerful ingredients that are effective at ultra low doses "super-molecules", like Ambrostar® (woody-amber), Z11® (dry woody), Pomarose® (apple-rose), etc. The industry is increasingly favouring these high-impact, highly effective ingredients, which reduce the volume of raw material and amount of energy to produce them, reduce transportation volume, and reduce environmental waste.

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.

Most of the large chemicals used in F&F date back more than 60 years and have changed little in that time. Unlike the electronics sector, which has miniaturised its products, the F&F industry remains centred on the use of massive, energy-intensive chemicals – not due to a lack of talent, but rather because of a status quo approach in which sustainability is only one of several competing drivers.

The biodegradability paradox

Alongside cost, biodegradability is a key criterion for selecting aroma chemical ingredients. The fragrance and flavour industry is making strong efforts to design more biodegradable materials – but full and meaningful biodegradability is rarely guaranteed.

Standard tests are conducted under ideal laboratory conditions – aerobic, aqueous, and nutrient-rich – which don't always reflect the complex, variable environments of the real world. A molecule might pass the test (e.g., 60% degradation in 28 days) and still persist partially for months or even years in natural ecosystems. Some substances also fragment into smaller components, including potential micro-pollutants, without achieving full mineralisation.

In this sense, biodegradability remains an imperfect and often overstated concept.[27][28] Paradoxically, it may be more environmentally sound to use very small amounts of low-biodegradability materials than to deploy massive volumes of partially biodegradable ones. This trade-off – together with the pressure to reduce carbon emissions – is one of the strongest drivers pushing the F&F industry to rethink its model.

The key question becomes: how do we shift our F&F industry from using 500,000 tonnes of carbon-based conventional aroma chemicals to just 10,000 tonnes of highly impactful molecules? (see **Figure 10**).

Developing high-impact, ultra-low-dose fragrance ingredients not only meets this challenge, but also opens new sustainable pathways, especially when their high value makes production from renewable biomass economically viable.

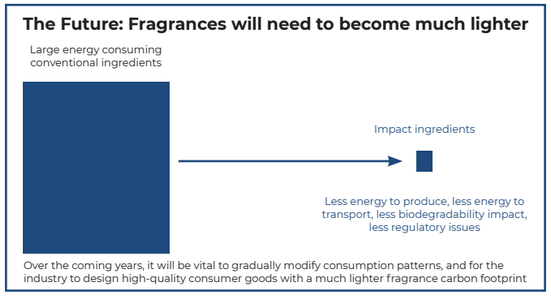

Figure 10: *Over the coming years, it will be vital to gradually modify consumption patterns, and for the industry to design high-quality consumer goods with a much lighter fragrance carbon footprint.*

Common sense: a lost virtue

The F&F industry is increasingly constrained by regulatory uncertainty – exacerbated at times by excessive decision-making sometimes developed in isolation in Brussels – and a fragmented industrial landscape. Many consumer goods companies and compounders show limited awareness or concern for the continuity of their own suppliers, 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 Mr Jean Mane in his address at the IFEAT 2026 Göteborg Conference on September 16, 2025, emphasising the resilience needed to preserve common sense amid regulatory and industrial turbulence[29]. Similarly, in his presentation "Will All the Flowers Be Gone?" at the IFEAT 2016 Dubai Conference on September 27, 2016, Mr 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 a structural challenge in strategic vision, partly linked to imbalances in leadership profiles. Senior roles are often concentrated among financial and legal professionals, which can contribute to a risk-averse culture and constrain innovation as well as long-term growth. This dynamic is particularly evident in publicly listed companies, where pressure to deliver short-term financial performance may overshadow broader strategic considerations. A strong focus on quarterly results can, in some cases, lead firms to underappreciate emerging market trends, shifting consumer expectations, and the importance of maintaining resilient, trust-based supplier relationships.

Frequent mergers, acquisitions, and spin-offs are often driven primarily by financial objectives rather than by long-term value-creation strategies, resulting in limited synergies beyond expanded customer access. In parallel, large workforce reductions - particularly among experienced professionals - can inadvertently erode organizational expertise when talent is treated predominantly as a cost rather than a strategic asset. Many of these specialists subsequently move to mid-tier companies, contributing to their rapid growth and enabling some to compete more effectively with established industry leaders.

At the same time, several large companies maintain operational practices that may inadvertently constrain their own performance – such as limiting travel and direct business interaction, implementing overly complex performance metrics, maintaining rigid organisational hierarchies, or placing disproportionate financial pressure on suppliers. Over time, these approaches can affect the broader ecosystem by reducing employee engagement, weakening customer proximity, eroding trust, and dampening creativity - factors that have historically underpinned the industry's capacity for innovation and long-term resilience.

In efforts to reduce costs, some companies may be tempted to compromise on quality, including for natural flavour ingredients that ultimately enter the food chain. In certain cases, genuinely natural components are replaced with unusually low-cost, natural-by-certification materials sourced from regions with inconsistent audit practices, increasing the risk of regulatory scrutiny in food applications and the potential for significant repercussions for the compounder. These circumstances underscore the tendency for short-term managerial pressures to extend the limits of ethical conduct. Rigorous due diligence and strong governance remain essential in sourcing decisions.

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

The untapped potential of biomass

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 depolymerisation, 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. Efforts to replace petrochemicals involve drastically cutting production costs – a challenge that has so far failed for biofuels.

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][31][32][33][34].

Although environmental regulatory uncertainty and geopolitical tensions may tempt some companies to delay investments in decarbonisation 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. 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[35].

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 small-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 systemic transformation, the F&F sector risks exacerbating its environmental footprint and undermining its long-term sustainability. The industry carries the privilege—and the duty—to leave a better legacy that inspires and uplifts the next generations.

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 life cycle 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.
- Prioritise 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.

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Advocacy Bulletin #1

Rebecca Lentini speaks at the IFEAT 2025 Göteborg Conference.

NOVE's Rebecca Lentini brings us the first IFEAT Advocacy Bulletin, keeping you up-to-date with the latest work of our Advocacy Group.

The **IFEAT Advocacy Group** aims to represent and advance the interests of the essential oils and natural ingredients sector before European and international institutions. Working in partnership with Charles Laroche and NOVE, IFEAT's Brussels-based public affairs consultants with extensive expertise in EU chemicals and sustainability policy, the Group's mission is to ensure that the voice of the industry is heard when policies and regulations are being developed.

This quarterly bulletin has the objective of informing IFEAT's membership of the work for the Advocacy Group. This edition includes articles on the IFEAT Conference 2025, the Group's ongoing advocacy on Omnibus VI, the Essential Use Concept and CLH developments, and the creation of an advocacy flyer designed to raise awareness of the sector's economic, social, and cultural relevance among decision-makers.

IFEAT 2025 Göteborg Conference – Strengthening our Institutional Voice

In September 2025, IFEAT hosted its **Annual Conference** in Göteborg, Sweden, under the theme "The Nordic Nexus," celebrating the innovation, sustainability, and heritage of the Nordic essential oils and aroma markets. The Advocacy Group played a leading role in incorporating the EU policy dimension to the event.

The high-level panel brought together Sylvain Bintein (European Commission, DG Environment), Paul Ryan (European Chemicals Agency), Christos Vasilakos (European Parliament), and Philippe Soguel (Distillerie Bleu Provence).

Panel Discussion – A new EU policy landscape

The high-level panel brought together Sylvain Bintein (European Commission, DG Environment), Paul Ryan (European Chemicals Agency), Christos Vasilakos (European Parliament), and Philippe Soguel (Distillerie Bleu Provence). The discussion focused on how the new EU political cycle (2024–2029), driven by priorities of simplification, competitiveness, and innovation, is shaping upcoming legislation affecting natural substances and essential oils.

Mr Bintein presented the EU Chemical Industry Package and the Omnibus VI proposal, which aim to simplify key regulations such as the Classification, Labelling and Packaging Regulation (CLP) and the Cosmetic Products Regulation (CPR) while supporting SMEs and maintaining high safety standards. Mr Ryan explained the classification and labelling framework and provided insight into current cases relevant to the sector, including tea tree oil and p-cymene. Mr Vasilakos underlined the importance of a science-based, risk-based, and enforceable REACH revision that protects human health and the environment while sustaining European production and innovation. Finally, Mr Soguel shared the industry's on-the-ground perspective, highlighting the need for proportionate, practical regulation to ensure the continued viability of producers and distillers across Europe.

Workshop – The EU and Essential Oils

The workshop, *"The EU & Essential Oils – A Beginner's Guide,"* provided participants with a clear overview of EU decision-making and current and upcoming legislation relevant to the sector. Led by Charles Laroche and Rebecca Lentini, the session provided an overview on the EU, its Institutions, and how it works. The session also concentrated on frameworks such as REACH, CLP, Omnibus VI, and the Essential Use Concept, describing their adoption process from a legislative perspective and how stakeholders can engage effectively in these processes.

Both Sylvain Bintein (European Commission) and Paul Ryan (ECHA) were present for the discussion, offering institutional perspectives and answering practical questions. The workshop helped bridge the gap between EU policymaking and industry practice, providing participants with a clearer understanding of how regulatory developments may impact essential oils and other natural ingredients.

Omnibus VI – Advocating for Proportionate Regulation

Sylvain Bintein presented the EU Chemical Industry Package and the Omnibus VI proposal at the IFEAT 2025 Göteborg Conference.

The **Omnibus VI package**, published by the European Commission in **July 2025**, seeks to simplify EU chemicals legislation while maintaining high safety and environmental standards. By streamlining key frameworks, such as **CLP** and the **CPR**, it introduces clearer procedures for assessing ingredients, more flexible and digital labelling rules, and reduced administrative burdens, helping make compliance more efficient without compromising protection.

For the essential oils sector, these updates are especially important to ensure that natural and complex substances are regulated in a practical and proportionate way. Together with EFEO, IFEAT has prepared two joint position papers, one for Members of the European Parliament and another for EU Member States, outlining the sector's priorities:

- Simplification, protection, and clarity in implementation;
- Preservation of high safety standards;
- A risk-based approach that recognises the natural complexity of essential oils;
- Support for securing the plant extracts derogation beyond 2029 to keep proportionate, science-based regulation of essential oils under the CLP provision.

The Advocacy Group's next steps include sharing these papers with policymakers and organising meetings with relevant institutional stakeholders to ensure the sector's concerns are reflected in the legislative debate.

The Essential Use Concept – Defining What is "Essential"

As part of the EU's *Chemicals Strategy for Sustainability*, the European Commission is considering the introduction of an Essential Use Concept. This principle aims to ensure that substances with hazard classifications are only allowed when their use is necessary for health, safety, or the functioning of society, and when no suitable alternatives exist. While the European Commission is still assessing how to apply this concept in the legislative context, IFEAT has taken a proactive approach by developing a dedicated White Paper on the Essentiality of Essential Oils, setting out the case for their recognition as essential within this evolving framework.

IFEAT's advocacy focuses on demonstrating that essential oils fulfil these criteria when their broader contribution is taken into account. They play irreplaceable roles in promoting physical and mental wellbeing, food quality, sustainability, and cultural heritage. Through a dedicated White Paper, the Group argues for a function-oriented and proportionate application of this concept, one that acknowledges the real-world benefits of natural substances and prevents unintended harm to local economies and small producers.

This position will continue to guide discussions as the European Commission finalises its Chemicals Industry Package later this year.

Advocacy Flyer – Bringing our Story to Policymakers

To complement direct engagement, the Advocacy Group is in the process of developing an informative brochure designed to introduce regulators and policymakers to the essential oils sector, its origins, benefits, economic contribution, and cultural significance.

The flyer traces the historical journey of essential oils from ancient traditions to modern innovation, highlighting their roles in perfumery, food flavouring, medicine, and wellness. It also features testimonials from scientists, medical researchers, and cultural experts who speak to the unique heritage and health potential of natural extracts.

The goal is to provide decision-makers with an accessible, engaging overview of why essential oils matter, not only economically, but socially, culturally, and environmentally. The content is now being adapted into a visually engaging layout and will soon be shared across institutional and industry channels.

Looking Ahead

The work of the IFEAT Advocacy Group further confirms IFEAT as a trusted, solution-oriented voice for the essential oils industry. By combining scientific credibility, cultural storytelling, and strategic engagement, the Advocacy Group is helping shape a regulatory environment that values both safety and sustainability.

The Advocacy Bulletin will continue to provide quarterly updates on our work, helping every IFEAT member stay informed, involved, and connected to the evolving policy landscape that affects our shared future.

Cooling Sensation Could Be Extraordinary:

A New Coolingness Booster to Achieve Temporal and Three-Dimensional Expansion of Coolingness

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Abstract
Cooling sensations are more than simple responses to temperature or chemesthetic stimuli – they are dynamic, multidimensional experiences that unfold over time and interact with sensory, cognitive, and affective systems. This paper introduces a novel framework for understanding and enhancing cooling as a temporally extended, spatially distributed, and cognitively modulated phenomenon. We review its evolutionary significance, molecular mechanisms via thermosensitive ion channels and the limitations of conventional cooling agents. By integrating phenomenological insights with sensory neuroscience, we propose innovative approaches for amplifying cooling effects, including targeted ion channel modulation, aerosol delivery for deeper sensory engagement, and top-down/bottom-up sensory integration. The synergy of cooling with taste and aroma further opens avenues for next-generation sensory design in foods, beverages, and personal care applications, positioning cooling not merely as a sensation but as a transformative sensory experience.

1. Introduction

Cooling is often taken for granted – a crisp, fleeting relief – but beneath this simplicity lies a rich, dynamic sensory experience. Traditional cooling agents, such as menthol and WS-3, primarily target TRPM8 channels and are limited by short-lived effects, localised sensations, and off-flavours at higher doses. These conventional approaches reduce cooling to a static, one-dimensional response, overlooking its temporal unfolding, spatial complexity, and integration with other sensory and cognitive cues. By rethinking cooling from a fresh perspective, we can unlock entirely new possibilities – creating immersive, multidimensional cooling experiences that go beyond a sensation to induce positive emotional responses, enhance cognitive refreshment, and deliver sustained physiological effects.

2. Cold Sensation: From Evolutionary Protection to Culinary Pleasure

The human relationship with cold is one of the most fascinating examples of how evolution and culture intertwine. Once merely a physiological reaction to environmental extremes, cold has evolved into a source of comfort, revitalisation, and artistic expression within food culture.

2.1. Cold as Evolution's Alarm

For early humans, the perception of cold was far more than just a physical sensation. It was a vital signal for survival. Sudden drops in temperature threatened frostbite, hypothermia, and the loss of mobility, prompting immediate physiological responses such as shivering, vasoconstriction, and the instinct to seek shelter or huddle together for warmth. These responses, however, extended beyond the moment of danger. The alert of cold guided broader adaptive strategies: it shaped migration across varied landscapes, inspired innovations in tools and clothing, and led to the controlled use of fire. Cold, in this sense, acted as evolution's alarm bell, structuring human behavior and fostering cooperation, skillfulness, and cultural practices. By attuning to this elemental force, humans were able not only to survive but to transform challenging environments into habitable spaces, weaving the experience of cold into the very fabric of human adaptation and ingenuity (Lezama-García, 2022; Lu, X.,2023;Saito, 2025).

2.2. From Instinct to Enjoyment

Over time, however, cold shifted from a signal of threat to a resource for cultural and sensory refinement. In contemporary society, this transformation is fully realised in rituals, medicinal practices, and, ultimately, culinary traditions including gastronomy and food innovation. Frozen desserts, iced beverages, and menthol-based confections exemplify how cold has been reinterpreted as a marker of elegance and enjoyment. Advances in food science now extend this legacy, with innovative cooling agents designed to prolong and intensify cooling effects. What began as an evolutionary safeguard has evolved into a sophisticated design element within modern culinary practice.

This dual function – protective in its origins and pleasurable in its modern applications – illustrates humanity's capacity to reinterpret natural signals. Within the food, beverage, and personal care industries, cold has become a multisensory instrument, consciously employed to enrich consumer experience and evoke cultural meaning. Its transformation from biological alarm to aesthetic resource exemplifies how sensory evolution becomes embodied in cultural practice, where physiological responses are re-signified through cognition, and primal sensations are converted into semiotic expressions of pleasure, refinement, and identity.

3. From Chili Peppers to Cold Sensation: Nobel Discoveries in Molecular Mechanisms of Thermosensation

In 2021, David Julius and Ardem Patapoutian were awarded the Nobel Prize in Physiology or Medicine for discovering the receptors that allow us to sense temperature and touch. Julius revealed how capsaicin, the active compound in chili peppers, activates a heat-sensitive receptor, while Patapoutian identified ion channels such as TRPV1 that detect heat and mechanical force. These breakthroughs resolved a century-old question of how thermal and mechanical cues are transformed into electrical signals in the nervous system, fundamentally advancing our understanding of pain perception and the biological basis of tactile sensation (Patapoutian, 2003).

TRPM8 and TRPA1, two key members of the transient receptor potential (TRP) channel family, mediate the detection of cooling and noxious cold, driving adaptive behaviors such as shivering, thermotaxis, and avoidance. Across species, TRP channel variants have evolved with shifted activation thresholds, reflecting adaptation to extreme climates (Dhaka,2009; Moayedi,2022). In humans, TRPM8 activation produces both cooling perception and physiological responses like vasoconstriction.

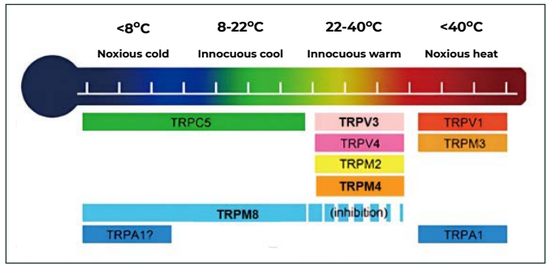

Figure 1: *TRP Channels in Thermosensation, Makiko Kashio and Makoto Tominaga, Current Opinion in Neurobiology, 2022.*

4. Current Prevailing Cooling Agents

Cooling agents are widely utilised compounds that elicit a perception of coolness upon contact with the skin or mucosal surfaces. Their applications span food, beverages, cosmetics, oral care, and medical products. These agents can be broadly categorised into naturally derived substances and synthetic analogues, each contributing distinct sensory characteristics and formulation advantages (Leffingwell, 2009,2014).

4.1. Natural Cooling Agents

Naturally occurring cooling agents are typically derived from botanical sources via distillation or extraction. Menthol, eucalyptol, and camphor remain the most representative examples. Menthol, the classical compound in this category, activates transient receptor potential melastatin 8 (TRPM8) channels and also influences other thermo-sensitive receptors, producing a sharp, aromatic cooling effect with rapid onset. Despite its effectiveness, the strong odor and bitterness of menthol present challenges in formulations requiring delicate or neutral sensory attributes.

4.2. Synthetic Cooling Agents

Synthetic analogues have been developed to address the limitations of natural compounds, offering odorless or low-flavour alternatives that deliver consistent cooling. WS-3 and WS-23 are the most widely used representatives. WS-3 provides

a mild cooling sensation with extended duration, whereas WS-23 is characterised by rapid onset but shorter persistence. Both are highly valued for their formulation flexibility and lack of inherent aroma. Additional derivatives, such as menthyl lactate, further expand the design space for tailoring cooling intensity, onset, and longevity, enabling customised sensory experiences across diverse product categories.

5. Reconceptualising Cooling Sensation

Traditionally, cooling sensation has been viewed as a direct somatosensory mapping of cold stimuli via peripheral thermoreceptors. Increasing evidence, however, shows that it is a heuristic, context-dependent construct shaped by the integration of peripheral inputs with cognitive, affective, and interoceptive processes. Thus, cooling extends beyond physical temperature to reflect learned associations and multimodal integration, reframing it from a physiological reflex to a dynamic perceptual phenomenon.

5.1. Phenomenological Perspective: Beyond of stimuli-response pathway

Modern scientific approaches to perception, heavily influenced by Cartesian philosophy, often dichotomise experience into subjective and objective domains. While this distinction has facilitated rigorous empirical investigation, it can inadvertently reduce complex sensory phenomena to measurable parameters, thereby constraining understanding. Cooling, for instance, is frequently interpreted merely as a change in temperature rather than as a meaningful, embodied experience. Drawing on Merleau-Ponty's Phenomenology of Perception, cooling should be conceptualised as an active, intentional phenomenon, inseparable from context, prior experience, and the goals of the perceiving body (Jiaying Chen, 2025).

Phenomenology emphasises that sensation arises from the dynamic interplay between body, environment, and consciousness. A cold breeze is not experienced uniformly as "cold"; it can feel bracing, soothing, invigorating, or threatening depending on individual circumstances, history, and expectations. Incorporating wine master Tim Hanni's concept of perceptual individualism, which identifies distinct sensory profiles among wine drinkers, highlights that thermal perception is similarly subject to inter-individual variability. Differences in sensitivity, prior experiences, and personal preferences significantly shape how cooling is perceived and interpreted, making it a highly individualised phenomenon.

Integrating phenomenology with contemporary neuroscience reframes cooling as more than a reflexive TRPM8-mediated response. Neural processing of cold signals occurs within multisensory and cognitive networks, where memory, expectation, and concurrent taste or tactile inputs actively modulate perception. Crosstalk among ion channels and interactions with other taste stimuli further indicate that thermosensation is not a linear stimulus-response pathway but an adaptive, context-sensitive process. Cooling thus emerges as an intentional, temporally and spatially structured experience, closely linked to both bodily states and environmental engagement.

5.2. Top-Down and Bottom-Up Cognitive Integration of Cooling Sensation: Beyond Bottom-Up Focus

Cooling perception arises from the interplay between bottom-up sensory cues and top-down cognitive processes (Vestergaard, 2023). Predictive coding frameworks posit that the brain continuously anticipates incoming stimuli, dynamically adjusting perception according to prior experience and expectation. When cooling is anticipated, even subtle thermal inputs can be perceived as intensified, whereas inattention or incongruent contexts may attenuate the sensation. Attention further modulates perceived intensity, selectively enhancing or diminishing the experience of cold. Collectively, these mechanisms illustrate that cooling is not a passive thermal input, but an embodied, context-sensitive phenomenon shaped by the interaction of sensory signals and cognitive modulation.

5.3. Temporal and Spatial Profiles of Cooling: Beyond of Intensity

The perception of cooling is inherently temporal and spatial, extending beyond mere intensity. Coolness is defined not only by magnitude but also by onset, duration, and decay, collectively shaping perception, expectation, and adaptive behavior. Rapid-onset cooling can elicit alertness, heightened attention, or surprise, whereas slower, sustained cooling may foster comfort, relief, or relaxation. Temporal dynamics interact with prior sensory experiences and cognitive expectations, such that anticipation can amplify perceived intensity while prolonged exposure may lead to adaptation or attenuation. These temporal features influence both immediate perceptual experience and longer-term emotional associations and memory formation, contributing to the significance and meaning of cooling.

Spatially, cooling is detected across multiple regions of the body and oral cavity. The lips, tongue, throat, and nasal passages sense gradients and directional shifts in temperature, shaping the qualitative and hedonic perception of cold. Spatial progression generates a sense of movement or depth, influencing behaviors such as swallowing, inhalation, or body repositioning. Chris Lukehurst's research on the emotional journey of taste, presented in his book The Shape of Taste, highlights the embodied nature of perception, indicating that spatial profiles of cooling are inseparable from affective and cognitive dimensions. Cooling perception is deeply intertwined with posture, movement, and environmental context, producing a richly integrated multisensory experience.

5.4. Integrated Perspective on Cooling Sensation: Beyond reductionism

Cooling agents like menthol and WS-series compounds activate TRPM8, producing a pronounced cooling sensation while modulating TRPM5 in taste cells. This TRPM8–TRPM5 crosstalk, together with interactions with taste, aroma and trigeminal pathways, creates a rich multisensory experience (Green, 2004). Neural integration across the insula, thalamus, and orbitofrontal cortex unifies thermal, gustatory, and olfactory cues, enhancing the intensity, persistence, and spatial complexity of cooling.

From phenomenological, neurocognitive, and individual-difference perspectives, cooling emerges as a multidimensional experience. Phenomenology emphasises its embodied, intentional, and context-dependent nature. Neuroscience highlights the interplay between sensory input and cognitive modulation, while perceptual individualism underscores how inter-individual differences shape perception and emotional evaluation.

Recognising cooling as a dynamic, adaptive, and deeply personalised phenomenon enhances our understanding of its physiological, cognitive, and affective dimensions, offering implications for sensory science, product design, and the study of human-environment interaction.

6. Expanding Innovation Horizons: New Frontiers in Cooling Sensation

6.1. Achieve Extraordinary Temporal and Spatial Cooling Perception by Enhancing Cooling Sensation through Inhibiting the Heat-Sensitive TRPV3 Ion Channel

TRPV3 (Transient Receptor Potential Vanilloid 3) is a thermosensitive ion channel abundantly expressed in epidermal keratinocytes, oral epithelial cells (tongue and palate), laryngeal mucosa, and the nasal epithelium. It is activated by innocuous warmth and plays key roles in maintaining mucosal integrity, wound repair, and barrier functions. Notably, TRPV3 exhibits activity-dependent sensitisation, whereby repeated stimulation leads to heightened responsiveness. In addition to its thermosensory and barrier-related functions, TRPV3 has been strongly implicated in the sensation of itch and pruritic skin disorders (Kalinovskii, 2023; Foote, 2023).

Thermal perception arises from the dynamic interplay between cold- and heat-sensitive ion channels, including TRPV3 and TRPV1, which can attenuate cold sensations. EPC Natural Products Co., Ltd. (hereinafter referred to as EPC), a science-driven company, has developed a novel approach that selectively inhibits these heat-sensitive pathways without interfering much with activation of TRPM8 or conventional cooling mechanisms. This strategy produces a robust, temporally extended, and spatially enhanced cooling perception, amplifying cold sensation across both superficial and mucosal tissues including the oral cavity, throat, and nasal passages. The same underlying mechanism is operative in the skin. By avoiding increased concentrations of cooling agents, this method minimises bitterness or irritation while delivering a multi-dimensional sensory experience.

6.2. Leveraging Aerosol and Emulsion Delivery for Physiologically Relevant Cooling

In EPC-funded research, it was demonstrated by Professor Jianshe Chen, Head of the Sensory Science and Oral Processing Platform at SIFBI, A*STAR, Singapore, and his colleagues that routine oral activities such as eating and drinking naturally generate aerosols facilitating the transfer of taste stimuli into the nasal and pharyngeal regions (He, 2024). This finding opens a new way to enhance flavour and cooling sensations. Menthol, being highly volatile, easily evaporates and enters these aerosols. With the right emulsion system, this process can be controlled to increase menthol delivery, intensifying and extending the cooling effect.

Building on this, advances in aerosol and emulsion technologies now allow precise delivery of cooling agents to areas of the mouth, nose, and respiratory tract that were previously hard to reach. Droplets sized 1–5 µm distribute evenly, contacting thermosensitive nerve endings and epithelial receptors to amplify the cooling sensation. Properly engineered droplet size also reduces irritation and ensures consistent sensory experience across foods, beverages, inhalable and personal care products.

By combining the natural aerosolisation of taste with precision delivery systems, EPC's approach creates a new frontier in cooling sensation, providing richer, longer-lasting, and more immersive experiences than traditional methods.

6.3. Performance Analysis Report of EPCool+007 in WS-23 Solution

EPCool+007, a FEMA GRAS-certified natural flavour, not only boosts the performance of existing cooling agents but also introduces a novel, memorable cooling effect for consumers.

6.3.1. Synergistic Cooling Experience from EPCool+007 and WS-23

WS-23 delivers a long-lasting but linear cooling profile, often perceived as monotonous. EPCool+ 007 accelerates cooling onset (43% faster) and slows down decay (44%), creating a more natural and dynamic temporal curve with layered fluctuations, especially when airflow engages the nasopharynx.

Spatial (location of cooling):
WS-23 cooling is concentrated at the soft palate and pharynx, leading to a narrow, throat-focused experience. EPCool+ 007 expands the cooling distribution by 53%, covering the full oral cavity and extending into the nasopharynx, achieving a three-dimensional and immersive cooling spread.

Embodied (overall sensory integration):
While WS-23 feels strong yet artificial due to its monotone cooling, EPCool+ 007 integrates speed, spatial breadth, and natural fluctuation to produce a richer, more organic embodied sensation. The cooling is perceived as multi-layered, adaptive, and closer to the natural dynamics of menthol-like cooling.

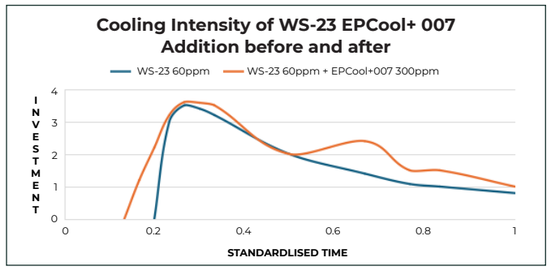

Figure 2: *Cooling intensity of 60ppm WS-23 with/without adding EPCool+ 007*

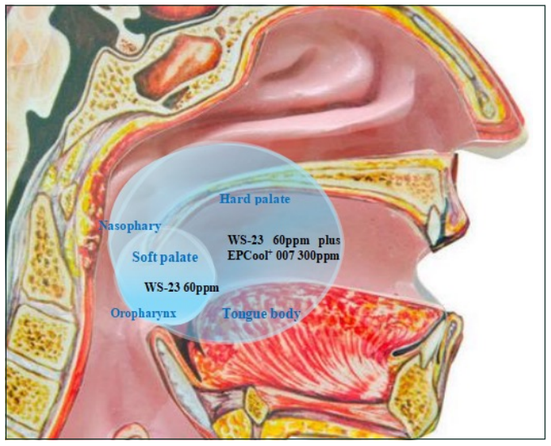

Figure 3: *Cooling Range of 60ppm WS-23 with/without adding EPCool+ 007*

6.3.2. Elevating the Cooling Sensation of Menthol with EPCool+ 007

EPCool+ 007 can replace 15 ppm of menthol, so that 35 ppm of menthol can reach the cooling peak of 50 ppm of menthol (Control), and at the same time have better performance in cooling onset (+50%), cooling duration (+67%), cooling range (+133%) and bitter taste (-100%).

The recommended addition amount of EPCool+007Liquid Version is 300 ppm. If there is a higher demand for duration, range, etc., the addition amount can be 600+ ppm, but it may have an impact on flavour.

Pleasant high-intensity cooling perception without bitterness. Although 50 ppm menthol provides a relatively pleasant cooling sensation, it is often accompanied by a noticeable bitter note. By adding EPCool+ 007 to 35 ppm menthol, an even stronger and smoother cooling perception can be achieved, surpassing that of 50 ppm menthol while markedly reducing its bitterness.

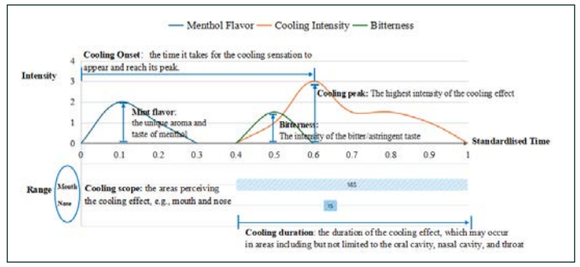

Figure 4: *Visualised Cooling Description of each dimension*

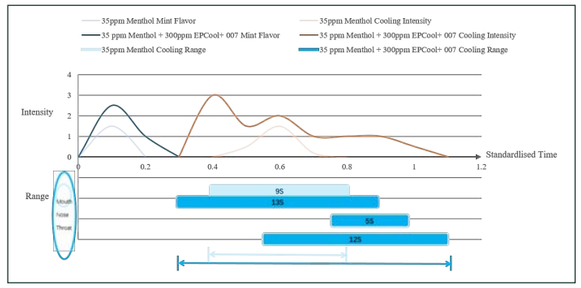

Figure 5: *Cooling Description Chart of 35 ppm with/without adding EPCool+ 007*

7. EPCool+ 007: Redefining Cooling and Functional Sensory Experiences

In 2025, global temperatures surged to unprecedented levels, with cities shattering historic records. Meanwhile, the world's largest iceberg, A23a, rapidly disintegrated – a stark reminder of the accelerating pace of climate change and its wide-reaching consequences. As the climate crisis deepens, future summers are expected to become longer, hotter, and drier than ever before. For fast-moving consumer goods such as confectionery, beverages, nutraceutical and personal care products, this drives a growing consumer demand for immediate comfort and functional sensory experiences. EPCool+ 007 delivers a rapid, intense, and long-lasting cooling sensation that activates oral, pharyngeal, and respiratory sensory pathways, providing perceptible refreshment, immediate throat relief, and anti-itch effects (Kaatzke-McDonald, 1996; Hossain, 2023). When incorporated into formulations, EPCool+ 007 synergises with conventional cooling agents to enhance and prolong their impact, allowing precise control over spatial and temporal cooling profiles. This multi-dimensional approach improves perceptual clarity, cognitive engagement, and emotional response, enabling the development of differentiated chewing gum, beverage, personal care, and nutraceutical products with both functional efficacy and memorable consumer experiences.

8. Outlook

Cooling is a complex, embodied phenomenon that unfolds across time and space, shaped by both sensory input and cognitive modulation. Its perception depends not only on intensity but also on temporal dynamics, spatial distribution, and the interplay of expectation, attention, and prior experience. By integrating phenomenological insight with contemporary neuroscience, cooling can be understood as a meaningful, intentional experience that guides behavior, informs emotional response, and structures human interaction with the environment. This perspective offers a framework for advancing research into sensory perception, affective experience, and multisensory integration, highlighting the richness of cooling as a core aspect of human sensation.

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Welcome to IFEAT

Francesca Perego, Chief Scientific Officer

What is your role with IFEAT?

I joined IFEAT in September 2025 in the role of Chief Scientific Officer.

Can you tell us about your background?

I have a Master's Degree in Chemistry from the University of Milan, immediately after which I started working in regulatory affairs in a flavour company called Kerry. After four years there, I joined a flavour and fragrance company as REACH and Regulatory Affairs Manager, and I worked there for more than 17 years, before joining IFEAT.

What are your key projects with IFEAT?

My responsibility as the CSO is to keep the Scientific Committee informed of current scientific and regulatory developments, follow advocacy activities, and maintain constant and productive cooperation with other associations and stakeholders. Our current focus is on exploring new regulatory developments, while keeping an eye on essential oils and trade.

What are you excited about achieving with IFEAT?

The most appealing aspect of this role to me was the opportunity to observe things from a different perspective – to be able to influence regulations instead of having to endure them once they are published; and having the ability to make a difference. The international environment and the discussion with highly trained colleagues involve me in stimulating dialogues that lead to both personal and professional growth.

Sheila Russell, Education Programme Officer

What is your role with IFEAT?

As IFEAT's new Education Programme Officer, I'll be working alongside the Education Manager to manage, develop, and deliver our remote learning programme. My focus is on providing excellent student support, ensuring quality, evolving our programmes, and engaging with the industry to create a high-quality learning experience. I'll be collaborating closely with students, industry experts, mentors, and other stakeholders to uphold academic standards and continuously improve the programme.

Can you tell us about your background?

I have worked in higher education for nearly two decades, initially as a lecturer at the University of Derby. Later, I served as Director of Studies on a bespoke Diploma programme that I created at the School of Artisan Food. During my time as a collaborative partner with Nottingham Trent University, I co-wrote the FdSc and BSc in Artisan Food Production. This was a groundbreaking course – the first of its kind, designed to deliver higher education skills combined with artisan expertise. I enjoy collaborating with industry experts to understand the essential skills and knowledge needed for success, and then translating that into inspirational and informative courses.

What are your key projects with IFEAT?

My key projects involve continuously updating our content, seeking out new academic reading material, podcasts, and cutting-edge research to enhance our platform. The goal is to ensure our online course consistently delivers what the industry truly needs and wants. The beauty of online learning is its agility – we can quickly respond to industry trends and ensure they are reflected in our platform.

What are you most excited about achieving with IFEAT?

The aroma trades industry is fascinating and incredibly diverse. I am excited to be working on an online educational platform with industry experts. This platform is designed for both those already working in the industry and those looking to enter it, so I want it to be a truly inspirational experience for students. I am particularly looking forward to developing interesting, contemporary content that showcases the best of the aroma trades industry and equips individuals with the skills and knowledge required for this exciting industry.

Klaus-Dieter Protzen 1933-2025

Obituary by Peter Greenhalgh

Klaus-Dieter Protzen, a dedicated businessman and influential figure in the international essential oils and aroma trade, has passed away at the age of 92. In 1977 he was one of the Founder Members of IFEAT and played a key role in its development. His life was defined by a deep commitment to the family company, Paul Kaders based in Hamburg, Germany, a passion for exploring the world, and a lifelong pursuit of specialist knowledge, especially of essential oils. His great passion was the Indian subcontinent, which he visited over 50 times.

Born in 1933, he lived in Hamburg until 1943, when the bombing of the city led him to move to near Dresden, where he witnessed the devastating bombing of that city by the Allies. In 1945, he returned to Hamburg with his parents. After graduating from high school in 1952, he initially wished to study chemistry, following his father and grandfather. However, his father, his great role model, convinced him that a career as a businessman was necessary for the continued existence of the Kaders company. The opportunity for extended stays abroad for professional and language training proved a seductive alternative. Following a two-year apprenticeship at a Hamburg import/export company dealing in East Asia products he joined Paul Kaders. After a one-year probation, he spent six months each in Spain, North America and Grasse focusing on essential oils. In 1986, after his father's death, he took over management of Paul Kaders with his brother, Peter, who handled administrative aspects. Peter left the business in the early 2000s and his son, Jens-Achim, took over as Managing Director. Klaus-Dieter gradually withdrew from the business and, sadly, the last 15 years of his life were marked by a progressive illness.

Alongside his IFEAT work, for which in 2023 he received the IFEAT Founder's Award, he helped organise many study tours and was closely involved in German industry associations. These included the VDC (Drugs and Chemicals Association), and SEPAWA (particularly the German Society of Perfumers), where he initiated the Perfumery Afternoon at the SEPAWA Annual Meetings and served on the advisory board for many years. His hobbies included photography (collecting slides and videos of essential oil extraction), mountain hiking, cycling, and culinary delights. He was supported by his wife Marianne, with whom he had three children: twin daughters followed by a son. We send our deepest condolences to the family.

Alongside his IFEAT work, for which in 2023 he received the IFEAT Founder's Award, he helped organise many study tours and was closely involved in German industry associations

Vincenzo "Enzo" Corleone 1937-2025

The international flavour and fragrance industry mourns the loss of a pivotal figure, Vincenzo "Enzo" Corleone, founder and long-time President of Agrumaria Corleone, who has passed away at the age of 88 after a brief illness.

Enzo transformed a local family enterprise into an international benchmark for citrus derivatives, with the company now successfully guided by its fourth and fifth generation, including his niece, Antonella Corleone – a former Chair of IFEAT's Executive Committee, who currently sits on the EC as a co-option.

His journey began in Palermo. Still a boy, he learned the trade on the factory floor, balancing school with shifts alongside his older brothers. Here he developed the deep, innate understanding required to recognise the essence of a ripe lemon and master the art of perfect extraction. In the 1950s, Enzo and his brothers took up the mantle of the company founded by their grandfather Salvatore. Driven by the post-war desire to expand Sicilian products abroad, Enzo dedicated himself entirely to the business after finishing his studies.

For over 50 years, Enzo led Agrumaria Corleone to the global sector's highest ranks. Visionary and charismatic, he possessed an end-to-end knowledge of

the citrus supply chain, which allowed him to innovate constantly while preserving tradition. He was among the first to see the potential in emerging markets, establishing strategic collaborations that introduced the world to Sicilian citrus.

Beyond his entrepreneurial vision, Enzo was guided by human values. He viewed the company as a second home, frequently stressing that success came from teamwork among the passionate group of technicians, workers, and collaborators he assembled. During both IFEAT Study Tours to Southern Italy and Sicily (in 2009 and 2024) he generously hosted and warmly welcomed Study Tour delegations to Agrumaria Corleone's facility.

Agrumaria Corleone announced his passing with deep sorrow, stating that he combined "entrepreneurial vision with human values, making the company not only a workplace but a true family". His heirs added that he was "an example and a guide. A passionate entrepreneur who transformed a family business into an international point of reference."

Enzo Corleone remained present in the company until the end, leaving behind a powerful legacy of innovation, commitment, and passion for the Sicilian citrus industry.

Tom Buco 1956-2025

Tom Buco, president of Excellentia, has passed away. Tom's sons, Dan Buco and Jeff Buco, provide this tribute.

Throughout his remarkable career, Tom was a pillar of the flavour and fragrance industry – admired not only for his expertise but for the creativity and relentless dedication that leaves an indelible mark on all who had the privilege to work alongside him. Tom's leadership helped shape the very foundation of Excellentia. The values he instilled – integrity, kindness and an unwavering pursuit of excellence – continue to guide and inspire us each day.

Beyond his professional achievements, Tom was a man of immense compassion and warmth. He had a gift for making others feel seen and valued, and his kindness knew no bounds. Whether offering mentorship, friendship, or simply a listening ear, Tom touched countless lives with his empathy and grace.

His absence leaves a void that cannot be filled, but his spirit will forever remain woven into the fabric of our company and our hearts. We will always cherish his laughter, his wisdom, and the light he brought into every room.

Tom's legacy will live on through his family, the many people he inspired and the enduring example he set.

NEW IFEAT MEMBERS

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Email: **jleonard@florachem.com / chunt@florachem.com**
Website: **florachem.com**

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Website: **joysuncitrus.com/en/home-page-en**

Leading Chinese trader and distributor, established in 2008, specialising in citrus oils and other natural essential oils, always being enthusiastic for innovations and opportunities.

Anhui Jinhe Industrial Co.,Ltd
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Website: **en.ajhchem.com**

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NEW IFEAT MEMBERS

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CPC Industrial Zone, Plot 6, 7, 8 and 8a, 6th of October, Giza, Egypt

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Tanbo Food Ingredients is a food manufacturing corporation specialised in manufacturing dehydrated onion and essential onion oil of the highest quality from Egypt. With more than 35 years' experience in the dehydration sector, our founder along with the second generation have partnered with, Agrofood, one of the largest agricultural partners, with more than 25 years' experience in producing high quality harvest from Egypt, to achieve a fully traceable and sustainable product, controlled from seeds to finished goods for satisfied customers worldwide.

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