F&F INGREDIENTS: A CHANGING MARKET

BY ALAIN FRIX, FOUNDER, ALLCHEMIX BV

The F&F industry is probably one of the most complex industries, as it involves art, science and culture, combining the intricacies of nature and human ingenuity.

AN ELEGANT AND IMPORTANT INDUSTRY

Each of the products which compose our palette, be they natural or man-made, will drive people to purchase consumer goods which contain them: a fine perfume, a child's lollipop, a cosmetic, a detergent for clothing, an incense stick to inspire, a refreshing beverage on a hot summer's afternoon. Indeed, flavours and fragrances evoke a large spectrum of emotions, invisible partners in reassurance, seduction, appetites, relaxation and meditation, a conjunction between well-acting and well-being.

The F&F Industry is not only about stimulating emotions, but also a significant provider of work and income to over ten million farmers worldwide as well as other people involved in transforming natural feedstock into a highly diversified offering of perfumes and flavour materials. Equally important are those technicians who spend their lives creating new synthetic molecules which have apparently been "forgotten by nature," carrying out research guided by scientists in chemistry, biology, physics and finally IT. All these materials will fill the magician's hat of those perfumers and flavourists who can assemble these olfactive colours into a quantum of happiness.

Whether synthetics or naturals, F&F aroma ingredients are mostly relatively tiny hydrocarbon molecules. Solvents, fillers, carrier agents, preservatives or other products which do not contribute to odour or taste are excluded from this definition of aroma ingredients. Furthermore, from an ingredient standpoint, there is no universal rule - as long as regulation permits - that a fragrance ingredient could become a flavour ingredient and vice versa.

QUANTIFICATION OF THE F&F INDUSTRY

Many articles provide F&F industry turnover without a good indication of volumes. Moreover, turnover estimations are always subject to the price volatility of ingredients and therefore a weak indicator in volatile markets. Nature produces a biomass of hydrocarbons; it does not produce bio-dollars nor bio-euros. To assess F&F renewability and sustainability factors, it is necessary to estimate volumes as a key indicator, helping us to think proactively where and how to source material in the future — those pools of hydrocarbons that we will continue to tap for both synthetic and natural odouriferous substances.

COMPLEXITY OF F&F INGREDIENTS

There are over 1,500 main types of fragrance ingredients and over 3,000 main types of flavour ingredients. Generally, each product type is available in different commercial grades or purities. Very often further specifications are required, involving detailed analysis of all components according to dozens of parameters. Manufacturers need to guarantee perfect product performance and safety in their application, and the absence of traces that could create off-notes (human sense of smell can detect traces with a very low odour threshold). It is unusual to see the same aroma ingredient being prominent in both F&F industries, often a major ingredient used in fragrances — dihydromyrcenol for example — will have a much smaller, even negligible presence in flavours. And vice versa, a sizeable flavour ingredient, such as vanillin, will likely be present only to a smaller extent in fragrances. Besides, both markets comply with different regulations (REACH for fragrances, but not for flavours, food versus skin allergens, etc.). From a structural standpoint, the fragrance market is quite globalised, while the flavours market is much more fragmented and relies more on local producers of ingredients. Cultural values start with food and tradition, the taste of your first spoonful will constitute the first steps of a long cultural journey. Quite likely, as a result, flavours reflect ethnicity even more than fragrances do. The combination of all of the above explains why the F&F world is extremely complex and this complexity is further increased with issues related to raw material availability.

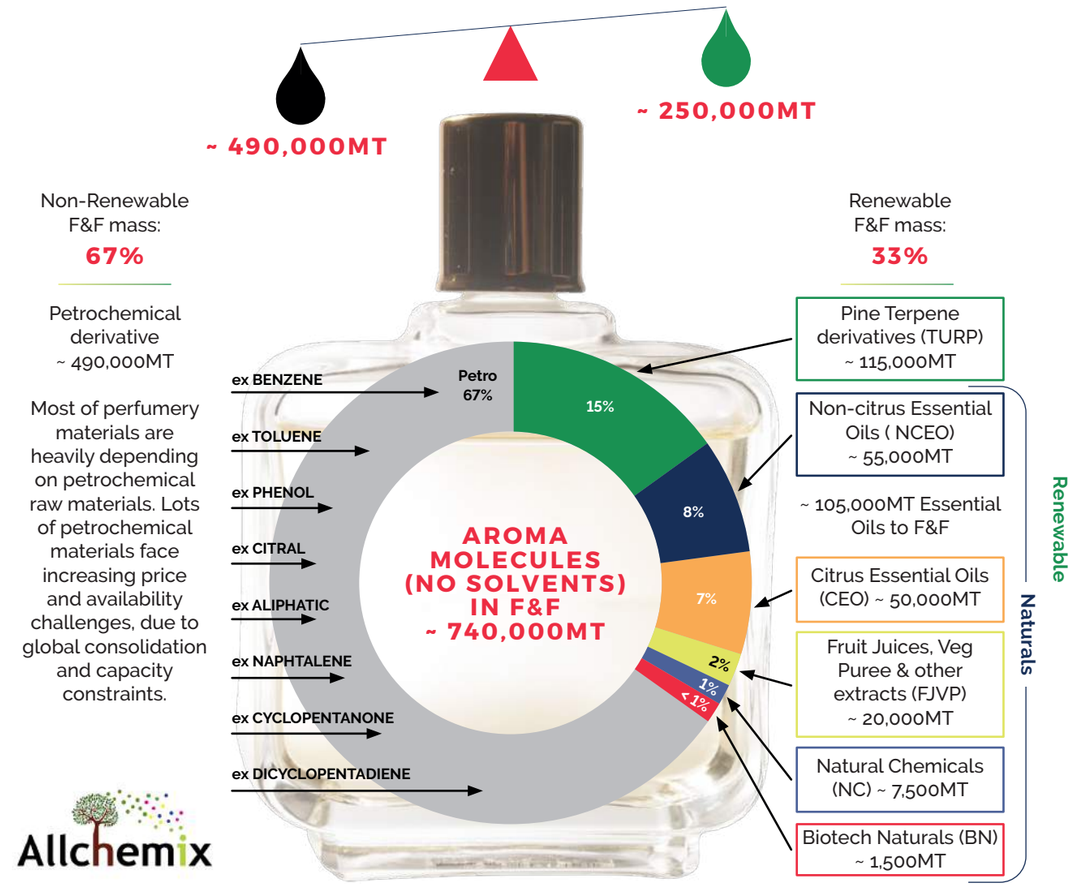
CERTIFICATES, REGULATIONS AND CASUALTIES

In recent years, further requirements such as renewability, traceability, sustainability programmes, organic or vegan nature and compliance with the rules of a myriad of other certifying bodies have added a sizeable burden and complexity. These additional constraints have proven to be very demanding to many small producers, as they lack the personnel or expertise to complete the paperwork being requested. Ultimately many small players discontinue or sell their business to larger entities, which are facing continued consolidation themselves. The pond of F&F companies is being drained at an alarmingly fast rate as a result of excessive and often unnecessary regulations.

SOURCES FOR F&F INGREDIENTS AND ESTIMATION OF USAGE LEVEL

For this study, the aroma ingredients are classified into five main categories or segments. They are interconnected in complex streams of materials and these will evolve as the F&F market is exposed to new stimuli from consumer demand, regulations, technology and biomass availability. The calculations which follow are estimations of a substance's aromatic components following correction referring to all masses being expressed as 100% pure products (*Figure 1*).

FIG 1. SOURCES OF F&F AROMA INGREDIENTS



Turpentine derivatives (TURP):
Turpentine is a renewable product extracted from pine trees, as a by-product from the tree tapping resins, as well as a by-product from cellulose (pulp) production. Most of the turpentine derivatives used in F&F are chemically transformed and therefore considered synthetic by regulatory bodies. About 115,000 MT of turpentine derivatives end up as ingredients in the F&F world, which equates to about 15% of the total F&F aroma feedstock. Other industries also consume turpentine derivatives such as agrochemicals, polyterpene resins, solvents, pharmaceuticals and camphor. More industries will look toward turpentine derivatives as a source of renewable feedstock in the future.

Essential oils and extracts (NCEO+CEO):
All are natural and renewable products. In some rare cases, extracts might be chemically transformed into other ingredients to become renewable synthetics. There is a global biodiversity of essential oils, with an excess of 200 commercial essential oils, providing vital resources to both developed and less developed countries. About 105,000 MT of essential oils are used in the F&F trades each year. As their production provides work to millions of farmers, they are by far the biggest socio-economic contributors of our industry. Although essential oils are primarily geared towards the F&F industries, there are increasing applications in the aromatherapy, pharmaceutical, organic phytosanitary products and other ancillary industries.

Other extracts such as fruit juices and vegetable purees (FJVP): these are almost exclusively used in flavours and are much less concentrated than their corresponding essential oils. The use of fruit juices and vegetable purees and other extracts is quite sizeable in flavours, roughly equivalent to about 20,000 MT of pure aromatic component.

Natural chemicals (NC) and biotechnology naturals (BN):
These chemicals are produced complying with either US or EU natural chemical protocols. An

A CHANGING MARKET
F&F INGREDIENTS:

estimation of volumes is 9,000 MT, which includes biotechnologically produced products, though the latter do not currently exceed 1,500 MT annually. Most biotech processes are designed to produce natural substances, although biotechnology can also be used as a processing step toward synthetic products.

Petrochemicals (PETRO):
All their derivatives are synthetic and not renewable. Some F&F ingredients might be produced through chemically binding a petrochemical derivative with a renewable chemical coming from one of the above-mentioned four sources. In such cases the final ingredient will be a "partly renewable" synthetic. Petro-derived aroma chemicals are prevalent in F&F ingredients: up to 490,000 MT per annum. The predominant use of petrochemical materials is in industries other than ours: vitamins, printing, construction polymers, agrochemicals, plastics, etc. It is interesting to consider if these petrochemical companies will be able to run their plants based upon renewable streams such as bio-naphtha or other new pathways. There might be a number of logistical constraints in these scenarios. In any case, the F&F industry will be under high pressure to phase-out the utilisation of fossil hydrocarbons. It is foreseeable that petrochemicals – currently often the cheapest source of F&F ingredients – will become more expensive, as they will very likely be subject to the environmental CO_2 tax which is absent until now. Renewable ingredients should logically benefit from a lower CO_2 tax regime.

Summary of aroma ingredients (without solvents):
Some 739,000 MT, out of which 582,000 MT are used in fragrances and 157,000 MT in flavours. These aroma ingredients are mixed with various delivery systems such as solvents, fillers, preservatives, vegetable oils, etc. The combined weight of commercial flavours can easily be many times greater than the weight of its core aroma components. In fragrances, this multiple is generally smaller than in the flavour industry. It is interesting to note that over 230,000 MT of solvents – mostly synthetic and only very few renewable – are used in F&F. If the above estimations are valid, the global F&F industry needs less than 750,000 MT of smell and taste hydrocarbons. This is probably less than 0.1% of the global chemical industry's hydrocarbon output. Interestingly, various rigorous studies indicate that pine forests naturally release great amounts of VOC including terpenes. Some estimates exceed several hundred millions of tonnes per annum of forest "fragrances." How does that translate with the new VOC regulations for fragrances? This is a topic that merits more attention.

NEED FOR MORE RENEWABLES

The key drivers of renewability are mainly turpentine derivatives and essential oils (and their extracts): they allow 30% of F&F's aromatic substances to be renewable. This is not enough as the demand for more renewable consumer goods is mounting.

Turpentine derivatives, with a weight of 115,000 MT, are a very important feedstock for perfumery. Turpentine itself is one of the smallest by-products of the softwood timber industry by tonnage, starting from over one billion MT of softwood biomass to produce wood, paper, resins, etc. This black box on softwood biomass streams and their quantification is illustrated in *Figure 2*.

The future availability of turpentine will essentially depend on various factors including the demand for gum rosin, but more particularly the demand for long cellulose fibre, the fittest sustainable technology to produce them, and the availability of conifers in accessible areas. A good portion of conifers grow in boreal forests, mostly inaccessible wetlands. Conifers in accessible areas exhibit early symptoms of climate change, some already suffer from invasive insect plagues. While complex, the coniferous biomass chain and streams offer many new avenues for renewable molecules in the next 30 years. Companies will need to find a new, smarter way to use them.

Essential oils are equally fundamental in today's renewability quest. This important F&F feedstock of 105,000 MT can be split into two categories: citrus oils and non-citrus oils.

Citrus essential oils represent about half of the total essential oil contribution to F&F. They are primarily extracted from the peel of oranges, lemons, and other citrus fruits, mostly as by-products of the citrus juice industry.

Non-citrus essential oils represent more than 150 products from lavender, cinnamon, patchouli, vetiver, and sandalwood being the most well-known, to the esoteric ones such as lovage root or cascarilla bark. These oils are the sole real source of renewable products intentionally made for the F&F market. In other words, production responds closely to demand. As they are naturals, the supply chain might not always be linear, but it is a fact that these essential oils play a major role in satisfying our demand for more renewable naturals. This is an important differentiation in contrast to the turpentine derivatives which are considered renewable synthetics.

ESSENTIAL OILS AS A CONTRIBUTOR TO HUMAN HEALTH AND SOCIO-ECONOMIC INCOME

Essential oils and their corresponding aromatic plants have coexisted with humans for a very long time and were carefully selected through so many generations of our ancestors for their healing, health-supporting and well-being properties. This very long relationship through highly diverse traditions can be considered as one of the most diligent assessment processes for reliability and safe product application that mankind has probably seen. Many essential oils outperform synthetic and biotech versions in fine fragrance applications. Although challenging to work with at times due to their richness, they certainly are of profound elegance. Synthetic molecules bring more flexibility, allow for more creativity and finesse, while often providing a better resistance to acidic or basic solutions (bleaches, laundry powders, etc.), which is important to prevent discolorations and odour degradation. This complementarity creates a welcome balance between feedstocks.

Furthermore, the social impact of these oils is of great importance as they provide work and income to rural communities, often operating in very remote areas of the world. IFEAT experts have estimated that over 10 million farmers are saved from poverty thanks to the aromatic crops which they produce, often in their small plots of land and at times with very ancient techniques. IFEAT provides high quality information on the socio-economic aspects of many essential oils at **https://ifeat.org/socio-economic-reports/**. These reports are also regularly published in IFEATWORLD. It is a moral pledge, by some, to better support these farmers, not only in views of generating corporate reports and obtaining various certifications. Without work, these families' situation might become precarious followed by migration to cities or seeing them risking their life on a boat. Everything is somehow interconnected.

SUSTAINABILITY OF F&F PRODUCT: MUCH MORE THAN CARBON FOOTPRINT CLAIMS

Sustainability is a concept that is prevalent in many recent discussions and plays a key role in future investment decisions. However, people may not always fully understand what sustainability is really about; they often forget the social aspect. Sustainability can be defined as a complex and dynamic balance between economic (increased yields, energy savings, etc.), environmental (renewable feedstocks such as biomass and energy, waste reduction, biodegradability, biodiversity, preservation of natural resources such as water, soils, etc.) and social matters (fair trade, profit sharing, access to genetic resources, rural economy, women empowerment, etc.). Some companies still express their sustainability efforts myopically through carbon footprint estimates. But carbon footprint itself is absolutely not a guarantee of a sustainable contribution to biodiversity, biodegradability, fair trade, rural employment, and so many other indicators that warrant a balanced business model. Social criteria are integral to the sustainability picture of each ingredient, and it is of increasing emotional value to many consumers in their purchase decision. As previously reported, millions of farmers, labourers, and pickers are highly dependent on our sector. Their lives form the third pillar of sustainability, the human footprint.

In fact, there are very few, if any, entirely perfectly sustainable solutions, and here again each feedstock has its advantages and its inconveniences. Often, a very good carbon footprint comes at the cost of a reduced social impact. It is a myth to believe that one can excel on all scores. In the end, a successful sustainable company is one that adopts the challenge to continuously improve on its own internal framework, year by year, regardless of whether it transforms petrochemicals or agricultural products into an F&F ingredient. The progress is more important than the score one keeps.

Moreover, the sustainability scores of both petrochemical-based and natural-derived industries are complementary. In other words, their weaknesses are different. Therefore, both main streams are absolutely needed to ensure an overall sustainable and reliable supply of molecules to our F&F industry, at least for the next three decades. And, as a result, companies should continue to invest on process improvements, both in each domain; petrochemicals and biomass.

Also, some definitions are being reviewed according to industry pressures. Recently, the European Union released a statement suggesting that natural gas could be perceived as a "transitory" sustainable solution in the decarbonisation efforts to move away from the so-called "more polluting" feedstocks such as coal. If so, how much would this policy impact in our tiny F&F market? The chemical industry's frightening dependence on natural gas already poses a real danger for the price stability of many raw materials, let alone the entire economy. Given the preponderance of petrochemical feedstock as well as gas in our F&F industry, one can foresee a higher frequency of future price instability in F&F and further consolidations as a result.

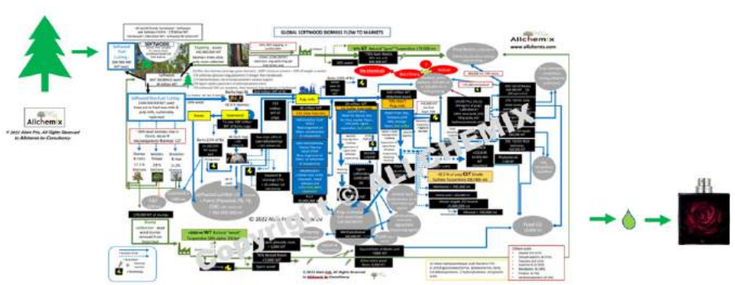
URGENT ACTIONS REQUIRED FROM CPGS

There is a real cost for sustainable practices. Farmers, especially small-scale farmers, are by far the weakest point in the full value chain of essential oils. While consumer goods companies rightfully impose more sustainability requirements on F&F houses and the entire supply chain, it is the farmer who mostly gets hit by the domino effect. As explained previously, over 10 million farmers and pickers, in the case of the essential oil industry, live at or just above the poverty level. They cannot be made the sherpas of sustainability. They need to be supported financially and socially and be educated in sustainable practices. Unfortunately, the prices that are being offered for their natural products often do not allow them to properly invest in better practices. Consumer goods companies and brands need to educate end-users that there is a premium to pay to really improve the livelihood of the farmer, and the environment. Some consumers will agree to pay a premium if they understand why they have to pay more and how this premium impacts our planet. Therefore, traceability needs to go in both directions—consumers need the ability to follow a product from the farmers' hands, but they also need verifiable evidence that the price premium effectively goes to the farmers and better farming practices. Only then will sustainability be truthful and impact the entire product lines, much more than today's initiatives, which are often limited and selected by major companies.

ESSENTIAL OILS AND THEIR SAFETY ASSESSMENT:

An urgent call for action: regulatory

FIG 2. FROM SOFTWOOD BIOMASS TO FRAGRANCES



bodies from the EU and other regions seem to struggle to understand natural complexity. The current mindset towards safety assessment protocols - evaluating natural complexes according to their individual components - is of great concern. This approach implies that the NCS (Natural Complex Substance - like essential oils) will react as if each individual component were to behave as if in isolation. This has been shown on several occasions not to entirely be the case. For example, several studies performed by the Research Institute for Fragrance Materials (RIFM) in collaboration with IFEAT indicate that the genotoxicity profile of whole oils containing chemicals of concern often demonstrates a much better profile than may be expected based on individual component analysis and pass the various genotoxicity endpoint tests. As an example, NCSs such as rose oil, which contains methyl eugenol, yielded favourable results, contrary to similar test results conducted on methyl eugenol alone, which was deemed to be unsafe. The approach to breaking down essential oils into individual components and establishing their safety profile based on algorithms using existing chemical databases could likely save costs and facilitate bureaucratic documentation, but it does not necessarily always reflect reality. There is only one way to accurately assess essential oils safely and that is by testing the essential oil per se. Will our F&F world embrace this initiative? Under the leadership of IFEAT, RIFM conducted genotoxic tests on almost 100 essential oils over the past five years, and, while some eight oils remain under review, the vast majority of tests carried out so far have not revealed any genotoxic concerns. Therefore, it seems that in various cases, the interactions between the constituents in NCSs attenuate certain properties and characteristics of the individual components in a favourable manner. Furthermore, it is worth noting that natural aroma chemicals do not necessarily have the same chirality as synthetics. Living organisms produce chiral molecules predominantly with a specific optical rotation, while chiral substances synthesised in the laboratory tend to be mostly racemic mixtures. It is well known that chirality can play a critical role in the physiological impact of chemicals on humans.

Let us not forget that any combination of ingredients, as safe as they could individually be, will undoubtedly lead to chemical reactions once they are mixed together, with the formation of some new compounds and degradation of others. The chemical universe of a detergent, a shampoo, a perfume or a flavour, cannot be the same as the sum of their individual constituents. To be pertinent and far more relevant, safety assessment should be done on the finished consumer goods product.

CONSIDERATIONS ON BIOTECHNOLOGY

Surprisingly, biotechnology is still relatively small in F&F. One of the reasons is probably the relatively limited market potential for most aroma molecules, and another factor could also be low yields and technically demanding purification. The challenges are to separate the yeast, or bacterial components, from the highly precious volatile components, which are small in quantity but of huge importance to define a rich olfactory note. For sure, biotechnology will progress and solve some of these obstacles, but it seems doubtful that biotechnology will play a significant role in F&F before 2030, at least for molecules selling for less than $50.00 per kilo. This pricing category, however, defines the vast bulk of F&F ingredients today.

BIODIVERSITY: A LONG WAY TO GO

At a time when all industries worldwide are mobilising efforts to preserve and foster biodiversity, our F&F industry could probably do more and take the lead in protecting more essential oils against pointless regulations, as well as further supporting oil safety assessments. Why not fund an international programme to specifically support essential oils against climate change? We will need this to adapt our crops to new climatic conditions. We might also need to improve our extraction techniques in anticipation of lower yields for the same climatic reasons. There are several examples of how to foster biodiversity. Maybe a good one is about Indian sandalwood, which was almost extinct due to grievous over-harvesting. In the late 1990s, the Forestry Department of Western Australia began to grow east Indian sandalwood trees as part of a global conservation programme. *Santalum album*, the east Indian sandalwood tree, showed promising potential. Today, more than 10,000 hectares of arid savannah landscape in Kununurra (Western Australia) have been transformed into an immense plantation of sandalwood trees, creating a new ecosystem, and providing income to the local population. These plantations created a new source of sandalwood oil of sustained availability, while the same was on the brink of extinction decades ago. Such projects should be acclaimed, as they are true vectors of biodiversity preservation.

MIGRATION OF OILS :

Essential oils are like people, they migrate. Some oil-bearing plants, like the almighty *Mentha arvensis*, have crossed several continents in the last century, chasing "better" growing conditions and economics. Today, various essential oils are leaving their endemic boundaries. There is no doubt climate change is having its effects, as even slight alterations to an ecosystem can have a large impact. A good example is, how global warming induced a fourth annual reproduction cycle for the pine bark beetle, killing millions of conifers throughout North America and facilitating widespread forest fires. There are various projects to grow essential oil crops in new areas, especially in West Central Africa, as these are likely to suffer much less from extreme drought patterns. Also, these new areas have little exposure to hurricanes or tropical storms. The author is also part of one of these projects, offering new alternatives to facing climate change, while supporting rural populations who have little to no income in a life of subsistence. Climate change will force producers to be active in multiple areas in order to reduce the risk to their supply.

YOU CAN'T CONTROL EVERYTHING

A good mapping of global renewable carbon streams should accompany R&D efforts from the very start. As biomass will be sought by many industries, availability will depend on several evolving and competing factors. Being cognisant of renewable streams' availabilities and qualities will be necessary to focus our R&D according to ever-changing indicators. Acquisitions and consolidation by stakeholders may be a partial answer to overcome these challenges, as it is virtually impossible to fully control the entire supply chain.

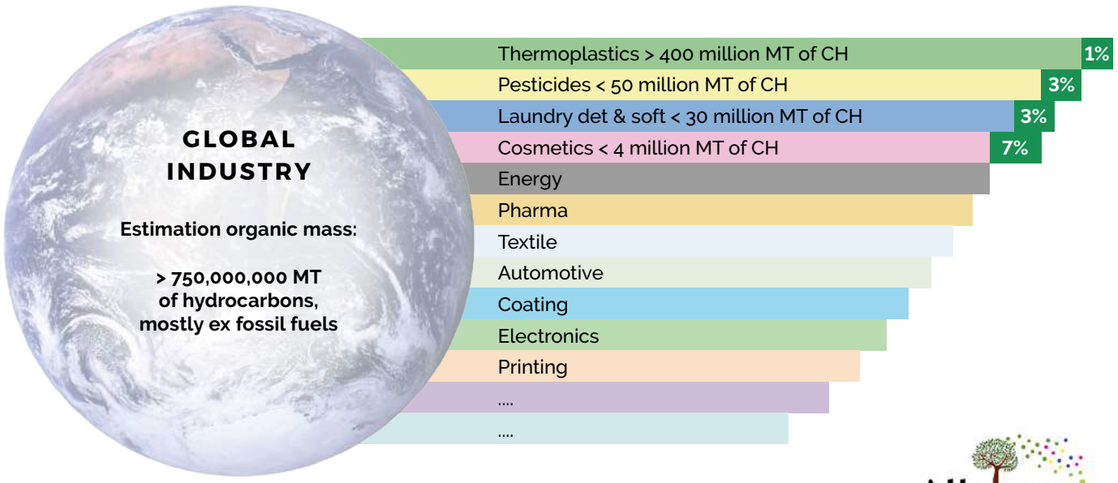
VENUE OF OTHER MARKETS AND PRINCIPLE OF GREEN GRAVITATION

F&F ingredients are often sourced from co-products and by-products traditionally sourced from other industries, a system that has been relatively stable for the past 50 years. However, each industry is now looking for more renewable solutions, driven by consumer demand for greener and cleaner products. This means that those industries might feel more obliged to keep and recycle their own organic waste, in particular, their waste of renewable substances. A rough estimate of some other industries' hydrocarbon consumption (in MT per annum) is a good exercise to predict new demand flows on renewable hydrocarbons (*Figure 3*)

WHERE WILL THE BIOMASS MOVE ?

FIG 3. OTHER WORLD NON-FOOD INDUSTRIES AND THEIR CARBON NEEDS

Global Non-Food Industry probably requires over 750 million tonnes of carbon



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- Thermoplastic industry: requiring 400 million MT of hydrocarbons, currently almost exclusively from fossil feedstock (and recycling less than 100 million MT each year). What will be the impact if thermoplastic industries were to add some renewable carbons to their feedstock? The thermoplastic industry would need three million tonnes of hydrocarbons to achieve 1% of increased renewability.

- Pesticides: possibly need 50 million MT of hydrocarbons; there is a big push for renewable feedstock such as turpentine derivatives as building blocks for new green agrochemicals.

- Laundry/detergents: possibly need 30 million MT of hydrocarbons.

- Cosmetics: could require up to 4 million MT of hydrocarbons.

This is not to forget other industries which will also compete with renewable feedstock, including energy, pharma, textile, automotive, coating, printing, and electronics beyond the growing sector of traditional biomass uses, such as lumber for construction and homebuilding.

These estimations are meant to illustrate that size does matter. As a result, there will be a "green gravitation," with the strongest market keeping and/or attracting the available green hydrocarbons. One might probably see new applications for renewable and natural materials. In conclusion, the many F&F ingredients constitute a complex universe, undergoing a big evolution due to its interdependence on other industries, regulations and, finally, climate change. The quest for more renewable materials across industries will accelerate the evolution of F&F value chains. In order to preserve supply continuity and respond to the demand for more green products, companies will need to think out of the box, or - pun intended - think out of the bottle!

ACKNOWLEDGEMENTS

I would like to thank several colleagues from the IFEAT Scientific Committee: Mr. Kim Bleimann, Dr. Jonathan Bonello, Mr. Ramon Bordas, Dr. Wladyslaw Brud, Mr. Hussein Fakhry, Dr. Peter Greenhalgh and Mr. Geemon Korah, as well as Mrs. Tina Hotchin, Mrs. Véronique Louis and Mr. Wolfram Ridder, for their valuable contributions and support in proof-reading this article.

ABOUT THE AUTHOR

Alain Frix dedicated 30 years to the business of renewable materials, from forest products such as turpentine and its perfumery derivatives to aromatic plants and essential oils.

After chairing the International Federation of Essential Oils and Aroma Trades (IFEAT) for several years, he currently chairs IFEAT's Scientific Committee and is involved in various projects related to aromatic plants, biodiversity and climate change. He is also a member of other prestigious associations such as SFP (Société Française des Parfumeurs) France; PCA (Pine Chemicals Association) USA (forestry derivatives from conifer biomass); SEPAWA (Europe's widest association for Soap, Perfumery, Detergent and Cleaners), Germany; DGP (German Society of Perfumers) Germany; VALBIOM (Biomass valorization), Belgium.

Alain Frix founded his consultancy company, Allchemix BV, in 2020. He has a master's degrees in biology and in management.

Alain is one of the speakers at the IFEAT 2022 Vancouver Conference and will speak on the subject of F&F Feedstocks & Renewability. His presentation will take place on Monday 10th October during the morning session at the Westin Bayshore Hotel.

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IFEAT

SOCIO-ECONOMIC REPORT ON CEDARWOOD OILS

BY PETER GREENHALGH

PART 1: CHINA AND THE USA[1]

INTRODUCTION

The term "cedarwood oil" can be confusing, in that the most important essential oils in this group are produced by distilling different junipers and cypresses (*Juniperus and Cupressus spp.*) rather than from true cedar trees (genus *Cedrus*). The *Oxford Encyclopaedia of Trees of the World* lists 34 tree species that have the common name "cedar" covering not only some of the above-mentioned species but also Thuja and Pinus spp. Cedarwood oil is commercially produced in many parts of the world and widely used. According to Milchard (2019) cedarwood oil is second in product volume only to the Pinus species of oils produced from the wood of essential oil-bearing plants.

The true cedar trees of the *Cedrus* spp are stately evergreen trees commonly divided into four species:

- *Cedrus atlantica* or Atlas or Atlantic cedar from North Africa
- C. *brevifolia*, the Cyprus cedar
- C. *deodara*, the Himalayan or Indian cedar
- C. *libani*, the cedar of Lebanon

Commercial "cedarwood oils" are obtained from three main genera of *Cupressaceae*:

- *Juniperus spp.* for Texas and Virginiana cedarwood oils
- *Cedrus* for Moroccan and Indian oils
- *Cupressus* for Chinese oils.

Part 1 of this socio-economic report provides an overview of cedarwood oil along with details of cedarwood oils from China and the USA. Also, in this edition of IFEATWORLD is *My Favourite: Chinese Cedarwood Oil (Cupressus funebris) and Firwood Oil (Cunninghamia lanceolata)* by Cathy Chen. This provides additional information and data on Chinese cedarwood and firwood oils. The latter oil is not discussed in detail in this report. The next edition of IFEATWORLD contains Part 2 which discusses cedarwood oils in India and Morocco and other smaller producers.

Many other cedarwoods are known, and have been distilled on a minor scale for their oil including:

- Nootka cypress (*Chamaecyparis nootkatensis* 'Glauca') sometimes called the yellow or Alaska cypress, which is a tall evergreen tree found on the west coast of Canada and the USA.
- *Chamaecyparis obtusa* (Siebold & Zucc.) Endl. – Japanese cedarwood from which "hinoki" oil is extracted from the leaves, branches and timber of the tree.
- Mulanje cedarwood *Widdrington whytei Rendle syn. W. nodiflora (L.) Powrie*.
- Port Oxford or Oregon cedarwood *Chamaecyparis lawsoniana*
- Weeping blue juniper *Juniperus recurva* Buch.-Ham.
- Hibawood oil *Thujopsis dolabrata* (L.f.) Siebold & Zucc. which was formerly used as a perfumery ingredient.

In addition, there is a small production of other cedar oils such as cedarleaf oil distilled from *Thuja occidentalis* from eastern white cedar (Trahan 2008). The main areas of cedarleaf oil production have traditionally been in New York, Vermont, Quebec, and Ontario, and some distillation has taken place in Michigan and British Columbia (western red cedar *Thuja plicata*).

USES, QUALITY AND COMPOSITION

Cedarwood oils each have characteristic woody odours which may change while drying out. The crude oils are often yellowish or even darker in colour if they are dry distilled in China. Some, such as Texas cedarwood oil, are quite viscous and deposit crystals on standing. They are used, sometimes after rectification, in a wide range of fragrance applications such as soap perfumes, household sprays, floor polishes and insecticides. Small quantities are used in microscope work as a cleaning oil and in the pharmaceutical industry.

Cedarwood oils have various uses in aromatherapy and as herbal remedies. Cedarwood has been known for thousands of years and is mentioned in the bible as a source of both wisdom and protection. It is claimed to have various medicinal properties including anti-inflammatory, stimulating blood circulation, protecting the scalp and skin from bacteria and environmental pollutants, lengthening sleeping time, reducing the onset of ageing, pain relief and acne treatment. Cedarwood oils are used to enhance relaxation and improve focus. For this reason the oil is being studied