

Crucial Ingredient Issues Dominate IFEAT 2014

Biotech's potential, the unique properties of Mediterranean and Turkish essential oils, the relationships between flavor companies and their customers, and more.

The 2014 meeting of the International Federation of Essential Oils and Aroma Trades (IFEAT) took place at Rome's Cavalieri hotel. Led by chairperson Antonella Corleone, the event focused on crucial issues and markets in the ingredient, flavor and fragrance sectors. Below is a selection of highlights from the program and photos from the conference and related events.

Rethinking Core Listing, Comfort Zones and More: the Relationship between Flavor Houses and their Customers

Today's flavor industry is highly competitive, said *P&F* columnist and flavorist John Wright during a spirited and perhaps controversial presentation. Flavors drive repeat purchases of products, and each flavor house has its own specialties, meaning these suppliers are not, as some customers might mistakenly think, interchangeable. Whether it's citrus, beverages, dairy, meat or any other food/flavor category, most flavor houses have specific areas of expertise upon which they focus.

Often, customers complain that flavor houses' R&D costs are too high, said Wright. In the past, he explained, flavor companies were discovering or inventing many aromatic ingredient "magic bullets" that drove sales. These types of developments are now relatively rare. As a result, Wright asked, is R&D infrastructure within flavor houses based too much on the past and not enough upon current relevance?

In-house raw materials drive sales, he continued, as do established flavors. It is quite difficult to return to "square one" and build new products based on outside-the-box thinking. In addition, flavorists can often work within comfort zones, said Wright, and are often not incentivized to think or create differently.

Meanwhile, from the flavorist's point of view, there is little time to work on projects, resulting in few iterations of flavor systems. In addition, flavor house-customer communication can be "fuzzy," said Wright. As a result, he noted, often the "least worst flavors" get chosen in order to meet impending plant production dates. When a flavor house wins with that least worst flavor, projects are often shelved or never launched at all.

While Wright acknowledged that too much emphasis is cost-driven, flavors may not be cost-optimized. At the same time, he said, core listing—originally instituted to control costs—has worked against quality. What can be done? Scrap core lists altogether? Keep the status quo? Wright proposed rethinking core listing by categorizing F&F houses by capabilities, within which suppliers could be ranked by category. At least three

competitors would be necessary within each category to ensure there is no "inside track" for incumbents, said Wright.

At the same time, communications could be improved by having flavorists work directly with customers, rather than sales staff serving as intermediaries. Use of a common language, face-to-face meetings and an insistence on openness from flavor houses will be crucial in this process, said Wright.

Wright added that there is a need for more flavorists to be trained by the flavor houses. Where is the training and recruitment, he asked, adding that it is rather difficult to get into the flavor industry. Newly trained flavorists could eventually be linked to key customers, he said.

Simultaneously, R&D could be "scaled back" and efforts refocused on optimized flavors that offer more "bang for the buck." After all, said Wright, most flavors are driven by a handful of ingredients. Traditional R&D focused on the analysis and discovery of new chemicals is not as lucrative as it once was, Wright said. The legacy of the analysis of nature has continued by inertia, he argued, yielding declining returns on fewer new materials of true interest. As such, R&D should be more customer-driven, focused on optimized flavors, cost-effective ingredients and avoidance of unnecessary complexity.

IFEAT 2015: Sri Lanka

The 2015 meeting of the International Federation of Essential Oils and Aroma Trades will take place in Sri Lanka September 27 to October 1. For more information, visit www.ifeat.org.





Priyamvada Sanganeria, Ravi Sanganeria, Bhuvana Nageshwaran, Sant Sanganeria and Prasenjit Mazumdar (all Ultra) during the Ultra Party on the rooftop of the Cavalieri hotel; photo courtesy of Ultra.



Nikki Vitulli (Phoenix Aromas), Fernand Sirvent (Berje) and Luc Ardouvin (Pdg Herbarom Laboratoire & Phytéo laboratoire) during the Ultra Party on the rooftop of the Cavalieri hotel.

Essential Oils: Consumer Product Perspective

Flavors: Essential oils offer brand distinction for products, said Edison Geromel (Coca-Cola), though flavors also comprise chemically defined flavoring substances and flavorings with modifying properties (FMPs). FMPs are able to offer flavoring at low levels or, at higher levels, other technical functionality such as sweetness enhancement. Using these types of materials helps the beverage industry, but these companies must be careful about use levels to maintain clear distinctions between sweeteners and flavors. This is especially crucial as flavorings are under increasing interest by regulatory agencies, said Geromel. Some of the agencies may not have ready understanding of flavorings, the result of which could be regulatory action not based on science. Thus, he said, it is important for the flavor industry to act in a structured basis and to share its knowledge with regulators via coordinated efforts involving ingredient and flavor suppliers and users. He added that industry should share best regulatory practices with agencies, including natural and artificial labeling on flavorings in consumer products. These efforts are crucial as attention ramps up on positive lists of permitted flavorings, workplace safety, nanotech and GMOs, said Geromel. This is not about safety issues, he stressed—after all, the industry's record of safe use of ingredients is well documented. Instead, the issue is building trust with all stakeholders to ensure key technologies—which could potentially resolve critical problems such as sugar reduction or citrus greening—are not prohibited.

Fragrance: Some time ago, Agnes Gendry-Hearn (Lush Handmade Cosmetics) and her colleagues began to notice quality problems with some of the oils they were receiving from suppliers. As a result, the company began to engage directly with growers and suppliers to build ingredient knowledge and establish the desired quality of materials. This was not only about product quality, she added, but also sustainability.

In its work with its supply chain, Lush has focused on the introduction of permacultures—“an agricultural system or method that seeks to integrate human activity with natural surroundings so as to create highly efficient self-sustaining ecosystems,” according to Merriam-Webster—within growing communities. The core of the concept was to ensure that the

permaculture systems gave more than they took, ensuring sustainability and stability. This has required the company to address soil degradation, collection and storage of water, and education of local communities in best agricultural practices. This system restores local plant life and productivity of the land, said Gendry-Hearn, while also boosting local incomes.

In the last four years, the company has undertaken 32 projects in 19 countries. Currently, permaculture investments represent 2% of Lush's yearly spend. Sustainable income is provided to local communities via non-exclusive partnerships. This is a business model, Gendry-Hearn stressed, not aid.

In Peru, Lush has supported sustainable rosewood oil production that does not require the cutting down of trees. Instead, only leaves and branches of living trees and the wood of dead trees are harvested, with distillation undertaken in a small setup in the forest. Lush also purchased all logging rights on a large piece of land and created a forest management plan to secure future supplies. Local animals are returning to their native land, said Gendry-Hearn, and locals have begun growing cocoa.

In Kenya, where Lush is sourcing geranium oil, locals are using intercropping with a distillation unit on the farm. Distillation has begun, said Gendry-Hearn, and 80 kg of oil has already been produced and applied.

In Ghana, where Lush sources moringa oil, intercropping is also being used on 24 acres for land regeneration. The company has a steam distiller in-country for the production of lemongrass, ginger, citronella and cinnamon for cosmetics. These will be applied to the local market until production and quality ramps up to sufficient levels for Lush's use.

Boundless Biotech?

Biotech, synbio, cultured ingredients—a rose by any other name could be engineered to smell as sweet.

A number of companies are vying for a piece of the potentially \$20-billion market for fine chemicals developed via biotechnology, said moderator Panchapagesa Murali (Evolva Biotech) in remarks opening an IFEAT biotech panel. This emerging industry is not, he argued, in competition with nature. Instead, Murali argued, biotechnology innovators seek to address challenges related to sustainability, consumer taste perception and

cost by harnessing the interdisciplinary sciences of biotechnology, evolutionary biology, molecular biology, systems biology and biophysics. The introduction of these materials is an add-on to the existing aromatic palette, he continued.

However, Murali acknowledged that industry, consumers and other stakeholders continue to ask questions about these materials' natural status, safety, regulatory oversight, impact on conventional aromatic crop farming and other related issues.

What is possible today: While biotechnologically derived materials offer many compelling potential applications, Jason Kelly (Ginkgo BioWorks) focused on what is possible today. Kelly described fermentation as, essentially, cooking with microbes in place of heat. Advanced biotech processes have been enabled, he explained, by increasingly inexpensive genome sequencing, which Kelly described as "probably the fastest improving technology in the world." How fast? According to data posted by the National Human Genome Research Institute (www.genome.gov), the cost to sequence a single genome in 2001 was about \$100 million. Today, the cost is well below \$10,000 and falling.

The more researchers learn about microbial cultures, the more they can be applied to product designs, whether it's spider silk created by AMSilk, leather produced by Modern Meadow or beef cultured by Google-backed researchers. Cultured products are already here.

Microbes are highly programmable, and virtually anything from a genome can be plugged in for a desired effect. Meanwhile, the science of biotransformation continues to grow, offering a quick and affordable way to develop products.

In the F&F world, the latest wave of biotechnology is being applied to aromatic materials such as patchouli, rose, valencene, nootkatone and more. Countless licensing and other agreements are currently in place between biotechnology houses and perfumery and flavor companies.

Meanwhile, Kelly noted that events such as iGem synthetic biology meeting allow students to show off their innovative tinkering for applications such as malodor solutions.

Improving on cost and other parameters: To produce products such as vanillin and saffron aroma via biotechnology requires highly technical teams with expertise in informatics, molecular biology, analytical chemistry and fermentation, said Pascal Longchamp (Evolva) during the session. The goal, he said, echoing Murali's remarks, is to create ingredients that are too rare to obtain from nature or to make an existing ingredient cheaper, more sustainable, safer, better tasting or even more soluble.

For example, said Longchamp, vanillin production is currently largely based on petrochemical processes, and chemically treated lignin, ferulic acid and eugenol, in addition to that extracted from the vanilla bean. That last source, he said, produces only about 60 metric tons a year. Implanting a novel route to vanillin production in yeast creates a natural fermentation product that meets sustainability, cost, purity and supply-stable requirements, Longchamp claimed.



Biotech panelists, from foreground to background, Jason Kelly (Ginkgo BioWorks), Pascal Longchamp (Evolva) and Toine Janssen (Isobionics).

The range of materials being produced has already expanded, he concluded, encompassing projects to produce biotech agarwood and saffron. The world, he said, is the limit.

Efficient processes: Cold-pressed orange oil contains less than 0.5% valencene, said Toine Janssen (Isobionics). Using yeast implanted with orange genes, he said, can allow a manufacturer to "brew" valencene at a much higher rate. (Janssen noted that the product of the valencene fermentation required further refinement before it becomes market-ready.) This method could be used as the building block for stable, relatively easy pathways to numerous ingredients. Janssen noted that, in addition to valence (in purities of 75% and 80%), it is possible to produce menthol, carvone, nootkatone (in 93% and 98% purity), limonene, α -pinene, humulene, patchouli, sandalwood, β -bisabolene and others.

According to Janssen's figures, 5 kg of sugar will yield 1 kg of valencene via a synthetic biology fermentation process. To derive the same volume of valencene from a botanical source such as oranges, he said, would require thousands of acres of trees—an unsustainable proposition.

Kelly added that the F&F industry could potentially make the argument that synthetic biology products—even those that are as much as twice as expensive as conventional ingredients—could be attractive to customers and consumers seeking to wean themselves off petroleum products. If so, synthetic biology ingredients do not have to exactly match or beat conventional product cost parameters to be successful and marketable.

Lifecycle analyses of these products are underway. In some cases, the speakers acknowledged that a biotech material might use more water than a synthetic pathway, but this is not confirmed. At the same time, improvements of technology, such as the use of continuous fermentation, could improve lifecycle analysis outcomes. Janssen added that, in the case of materials such as valencene, high transport and water usage costs for botanicals such as oranges make biotech overwhelmingly competitive.

What biotech means for the aromatic palette: Is it possible to create complete, complex essential oils via this route? Longchamp explained during a panel portion of the session that it is possible to make single or multiple aromatics in "one go." He said it was possible to create yeast cells that have same

activity of a patchouli plant, for example. It may also be possible to produce complex aromatic materials without unwanted components.

Kelly reiterated that the goal is not to replace existing ingredients but to offer new “creative opportunities,” for example a rose oil that is chemically different than its botanically extracted counterpart or new blends of ingredients. While Janssen acknowledged there is a way to go to make highly complex materials, Kelly explained that there are opportunities to boost margins and improve overall cost of ingredients.

Unanswered questions: During the question and answer session, Longchamp noted that under EU flavor regulations biotech ingredients qualify as natural because they are produced via fermentation. The status in the United States and Japan could take longer to define. The question becomes far more complex and more difficult to predict, however, when it comes to novel molecules produced via biotech processes—a move that has not yet occurred on the market.

Regulatory pressures: Could legislation changes kill these emerging technologies, particularly if regulators around the world choose to declare these fermented materials as synthetic? Already, groups such as Friends of the Earth are calling for a moratorium on the release of any GMO or synthetic biology products, declaring, “Synthetic biology could have serious impacts on the health of people and ecosystems, on our planet’s

biodiversity and for communities on the front lines of corporations’ plans to deploy new technologies and novel organisms for profit.” As the F&F industry well knows, threats from NGOs cannot be ignored.

Market potential: Booting up a biotech company requires time and investment, said Kelly, but that is not stopping the sector’s growth. These biotech companies are enabled via partnerships with companies in sectors such as fuel/biofuel and F&F. By Kelly’s estimation, the supplier base for cultured ingredients (strains, fermentation services, purification technologies, etc.) could expand to as many as 50 companies. This expansion, paired with improvements in biotech science, could drive significant growth in the natural ingredient industry.

Currently, the biotech sector is addressing the “low hanging fruit” in the aromatic ingredient market, but increasingly complex offerings could logically follow. Volumes of biotech ingredients remain low, said Murali, but growth opportunities will be driven in any ingredient segment that is currently facing sustainability, cost or other issues. If this occurs, Kelly said, the natural ingredient industry could be larger than the synthetic ingredient market in a decade.

One audience member inquired whether these fermented materials could one day be home-brewed, similar to beer. The panelists countered that, while aromatic material fermentation is similar to beer brewing, the products require too much



A view of the IFEAT’s opening cocktail reception at the Cavalieri hotel in Rome; all photos courtesy of IFEAT.



The event featured meeting areas where ingredient suppliers and customers met.



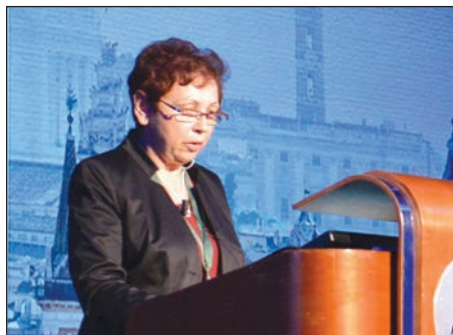
During the opening session of the IFEAT conference, from left: Ramon Bordas, Michael Boudjouk, Antonella Corleone, Alain Frix and Hussein Fakhry.



A view of Villa Giulia, the scene of the IFEAT dinner.



The Mediterranean comprises 21 countries and 465 million people and spans 7% of the world, said Jordi Sort (Ernesto Ventós).



Ana Rangus (Arxfarm) discussed Balkan essential oils.



Philippe Masse (Prodarom) discussed French essential oils.



The Mediterranean produces rosemary, thyme, oregano, fennel, marjoram, savory, aniseed, sage and other oils, said Joel Esteban (Ernesto Ventós).



Hundreds of medicinal and aromatic plants are produced in Turkey, including cultivated plants such as rose, aniseed and coriander seed, said Liat Murat Barbut (MG Gülçiçek).



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downstream processing to create the final product—not to mention the regulatory issues with ingredient production in one's home. That said, the accessibility of the technology could encourage startups, said Kelly. Microbes are highly programmable, and virtually anything from a genome can be plugged in for a desired effect. Meanwhile, the science of biotransformation continues to grow, offering a quick and affordable way to develop products. This accessibility and versatility, Kelly said, should keep the industry decentralized and innovative.

Could one of these startups be acquired by a F&F house in the future? When this question as put to Kelly he noted that biotech has so many applications—from pharmaceuticals to biofuel to aromas—that to be housed within any single sector would be needlessly limiting. More likely, he said, the partnership and licensing models seen today will persist.

Rose and Spice and Beyond: Essential Oils in Turkey

Hundreds of medicinal and aromatic plants are produced in Turkey, including cultivated plants such as rose, aniseed and coriander seed, said Liat Murat Barbut (MG Gülçiçek). The rose and herb/spice industries are the most important in the 21st century, she added.

Rosa x damascena is cultivated by many small families, primarily in Isparta, as well as Burdur, Afyonkarahisar and Denizli. Though produced on small farms, Turkish rose is primarily processed by factory-type steam distillation. Several thousand metric tons (MT) of rose matter is needed to make just a few kilograms of oil. For instance, said Barbut, 1.25 million flowers

are required to produce 1 kg rose oil. Top rose producers in the country include Sebat, Gülbirlik, Robertet, IFF-LMR-Erçetin and Biolandes. Total rose oil production in the country is 940 kg, rose concrete 6,925 kg and rose absolute 1,020 kg. These production quantities come as rose production has recently declined due in part to frosts and heavy rainfalls.

Turkish essential oil exports are primarily sent to France, the United Kingdom, Germany, the United States, Switzerland and Canada. The total value of exports of these products could be as much as €15.4 million, said Barbut.

She noted that methyl eugenol-free rose trials and organic rose production are underway, as well as more sustainable agriculture schemes involving larger farms. Currently, said Barbut, methyl eugenol can be removed via fractional distillation. However, the industry also faces a labor shortage and challenges related to usage of pesticides.

Barbut noted that herb and spice oils are often produced on small farms or from wild-growing plants, which are then processed by medium- to large-sized companies.

- The largest essential oil from Turkey, after rose, is oregano, which is produced in volumes of 15–20 MT per year. About 90% of this is exported; 70% of oregano oil used worldwide is from Turkey.
- Laurel leaf (*Laurus nobilis*) is produced at levels of 7–8 MT year; 80% of the global supply is sourced from Turkey and produced exclusively from wild plants. The government requires harvesting permits.
- Barbut explained that cumin seed oil is produced at a volume of 3.5 MT a year. The plants are cultivated for both the seed trade and distillation.
- Meanwhile, sage (*Salvia triloba*) is produced at a volume of 1.5–2.0 MT a year, said Barbut. The oil's main component is 1,8-cineole, whereas *Salvia officinalis* is thujone-rich.
- Rosemary oil is produced at a volume of 500–750 kg per year and is derived exclusively from wild-grown plants. The plant is used as both a spice and for essential oil distillation.
- Barbut said that anise seed (*Pimpinella anisum*) oil is produced at volumes of 20–300 kg per year. The seeds are used for oil production and for flavoring the traditional liquor, *raki*.
- Fennel seed oil is produced at volumes of 250–350 kg per year. It is also used in *raki*.
- Myrtle oil is produced at volumes of 200–300 kg per year, solely from wild plants.
- Coriander seed oil is produced at volumes of 200–250 kg per year from cultivated plants.

Unique Aromatic Qualities of Mediterranean Essential Oils

The Mediterranean comprises 21 countries and 465 million people and spans 7% of the world, said Jordi Sort (Ernesto Ventós). The region's unique climatic conditions allow a highly diverse range of vegetation to grow, jasmine, tagetes, lavender, lavandin, spike lavender, marjoram, chamomile, neroli, rose and more. These plants, though often found elsewhere in the world, feature unique aromatic qualities due to their environment and growing conditions.

Geranium: The region produces 80–100 MT of geranium oil per year (Sort acknowledged that all figures are estimates). The Mediterranean oil is sweeter and more rosy and earthy and



A view of the closing dinner.

less spicy and herbaceous than its Chinese counterpart due to a higher content of citronellol and geraniol.

Jasmine: About 2–3 MT of *Jasminum officinale* is produced in the Mediterranean each year, said Sort. The absolute is warm, sweet, fatty, floral, herbaceous and indolic-sharp. The ingredient's indole content rises in the warmer climates.

Citrus: The Mediterranean produces orange, lemon, bergamot, grapefruit and Italian mandarin, said Sort. Israel and Turkey produce about 60–80 MT of grapefruit oil per year. The Mediterranean variety has a higher nootkatone level; thus, it has a more citric character.

Lemon: About 1,100 MT of lemon oil are produced in Spain and Italy each year, 800 MT of which comes from Spain. The Mediterranean has a higher aldehyde content, which gives it more presence, body and citrus character. The Spanish quality has a citrusy fresh character and sweet odor and flavor, Sort explained.

Sicilian citrus: The island of Sicily produces several essential oils, including lemon, red and blond orange, and green, yellow and red mandarin, said Filippo Badalamenti (Agrumaria Corleone). Citrus runs deep in the culture. Reciting a local belief, Badalamenti said that some pregnant women in Sicily have eaten blood oranges in the hopes of creating beautiful children.

The fruits are produced by small to medium-sized companies. In recent years, the most popular processor system extracts juice and oil of the fruits simultaneously.

Sicily processes about 50,000–60,000 MT of orange, said Badalamenti, which results in 125–150 MT of oil. About 600–700 MT of lemon oil are extracted each year, while 25,000–35,000 MT of mandarin are processed each year. If mandarin is processed by pelatrice, the resulting oil is green. If the unripe green mandarin is processed with a sfumatrice or torchio extractor, the resulting oil is yellow. Ripe mandarins are processed for the red quality.

Sicilian blood orange has high valencene and carotenoid content, said Badalamenti. Lemon oil has up to 4% citral and has high sesquiterpene

content. Meanwhile, mandarin contains significant n-methyl anthranilate and β -sinensal levels.

Calabrian bergamot: Gianfranco Capua (Capua) and Stephen Weller (International Fragrance Association) presented research on the resilience of bergamot production in Reggio Calabria, where 100 ha of new plantings have been made. Production guarantees a stable income and is driven by continued investment in infrastructure, the presenters said. Producing the fruit is a win-win, Capua noted, while Weller underscored the importance of supply stability. Weller explained that the region produces 90% of global bergamot production across 1,200 ha.

Parsley leaf: About 1–2 MT of parsley leaf oil are grown in Egypt each year, according to Sort. Due to its apiol and myristicine content, the material is often applied medicinally for antimicrobial, laxative and other benefits.

Laurel leaf: About 12–20 MT of laurel leaf oil are produced in Turkey each year, said Sort. The leaves of the parsley plant contain 1–4% essential oil, so a significant quantity of botanical material is required for distillation. The oil is aromatic and spicy, appropriate for aftershaves, meat, sauces and soups.

Cedarwood Atlas: About 15–20 MT of cedarwood Atlas (*Cedrus atlantica*) oil are produced in Morocco each year, said Sort. The oil is sweet, fruity, fresh and more camphoraceous than other types of cedarwood. The oil's α - and β -himachalene content provides the key aromatic facets of the material.

Mediterranean pine: About 1 MT of Mediterranean pine oil is produced in Spain each year. The material has a similar terpenic base to other pine types, but is drier, more herbaceous, greener and fruitier.

Herb and other oils: The Mediterranean produces rosemary, thyme, oregano, fennel, marjoram, savory, aniseed, sage and other oils, said Joel Esteban (Ernesto Ventós). Thyme, grown in high dry areas, produces 30–40 kg per ha, he said.

Spike lavender produces 30 kg of oil per ha, sage produces 40 kg per ha, lavandin produces 30–40 kg per ha and wild rosemary produces 35 kg per ha, said Esteban.



An interior view of the IFEAT closing dinner.

French essential oils: In 1950, the Grasse flavor and fragrance industry was valued (in today's figures) at €180 million, said Philippe Massé (Prodarom). The value was mostly derived from essential oils and extracts, while 15% was from aroma chemicals and 10% from flavors. By 1970, the local industry was valued at an actualized €455 million or more. Since that time, the industry has been reshaped by consolidation, said Massé. Of the flavor and fragrance houses that existed in the region at that time, only four companies remain: Jean Niel, Payan Bertrand, Mane and Robertet. Today, the local industry is worth about €1.5 billion, with many top companies operating in the area.

Grasse produces ingredients such as jasmine, rose centifolia, orange blossom and violet leaves, said Massé. In 2013, the region produced 15 MT of jasmine flowers; the height of production for the botanical was 1920–1928. Each year, Grasse produces about 2,000 MT of orange blossom, 800 MT of rose centifolia botanical and 76.6 MT of rose centifolia oil, 50 MT of orris, 2,000 MT of clary sage, 80–100 MT of jonquil, 17–20 MT jasmine and 0.5 MT of tuberose.

French lavandin: Lavandin grows on 16,000 ha across the southeast of France, said Michel Krausz (Société Coopérative des Plantes à Parfum de Provence). Eighty one percent is grosso, 8% is super (this share is decreasing), abrial is 6% (and decreasing) and others make up the remaining 5%.

Since 2006, lavandin prices have increased 30%, compared to 71% for wheat during the same period. The lavandin price increase has continued in recent years, though slowly. Krausz noted that the aromatherapy market could have demand for 100 MT.

Global lavender production is between 80 MT and 220 MT, said Krausz, depending on climate and prices; the current total is about 142 MT. In France, he explained, lavender grows on 4,000 ha cultivated in three areas. Lavender areas are slowly increasing, he said, with varieties improving. Clonal lavenders such as Maillette, Matherone and Diva have contributed to price stability in recent years.

French production of lavender oil will likely never again reach the 90 MT that was seen in 2005, said Krausz, but it could eventually reach 60 MT. Oil yield per hectare is highly varied around the world, but in France it is 10–80 kg/ha.

Bulgarian lavender yields could be as high as 30 kg/ha. In Bulgaria, Krausz said, farmers sell plants to traders, who are also the distillers (some traders are also farmers), meaning the entire industry is organized differently compared to France. Bulgarian research has yielded varieties such as Sevtopolis, Drujba and Raya, and production has increased since 2010. Bulgarian lavender oil is of good quality, said Krausz, and traders are highly professional.

Lavender is also grown in Ukraine, though this year's military conflicts, tight credit and quality problems have resulted in a low production of just 2 MT, compared to 40 MT in 2005. Krausz noted that farmers might replace lavender with clary sage, sclareol and coriander because they can be produced with minimal investment. Moldova, he added, which in the 1970s produced up to 100 MT of lavender oil per year, has produced just 5 MT this year. The current material is often not up to industry standards.

China has also cultivated two varieties of lavender across 1,500 ha, with an oil production of 40 MT. China can have oil yields of 80 kg/ha due to irrigation of fields. The volume of oil produced varies depending on how much arrives at the fresh flower market, said Krausz. The oil is beginning to be offered to the world market.

Krausz estimated that the combined world production is between 80–220 MT, depending on climate and prices. The latest total is about 142 MT.

Balkan Essential Oils

The Western Balkans comprises Croatia, Serbia, Bosnia and Herzegovina, Montenegro, Kosovo, Macedonia and Albania, explained Ana Rangus (Arxfarm). Companies operating in the region import flavors, fragrances and essential oils, while export of compounded flavors and fragrances is primarily centered on East European countries. Slovenia and Croatia have the largest F&F industry.

Rangus explained that key oils produced in the region include angelica, wild laurel leaf oil, helichrysum (including wild-grown), wild juniper berry, chamomile, hyssop, lavender and lavandin, lemon balm, wild sage, lovage and parsley leaf oil. Gathering of wild botanicals is increasingly under more stringent regulation.

Helichrysum italicum has six key subspecies in the region, said Rangus. In 2013, 3 MT of helichrysum oil was produced. Enlargement of the cultivation of helichrysum and lavender is noticeable, said Rangus, with new plantations of *H. italicum* estimated to cover 50–60 ha. Meanwhile, juniper berry oil has the greatest range of production areas; production of the oil can range between 5–10 MT per year.

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