

# Lavender

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A recent contribution on perfumery notes by H.-M. Hoffmann dealt with the Chypre type, a very fine combination of citrus and woody-mossy notes.<sup>1</sup> Additional herbaceous nuances such as lavender are thereby often encountered. In the formula given by that author we see, for instance, in the so-called old-fashioned type, a dosage of 1.6% of lavender oil; in a second Chypre-type, 5% of lavandin oil. Thus, it becomes clear that it is not lavender oil alone which has to be discussed. When looking at the perfumistic effects reviewed under the heading of "lavender," we encompass the whole group: lavender oil itself (*Lavandula officinalis* Chaix or *L. vera* DC), spike lavender oil (*L. latifolia* Vill.) and lavandin oil (hybrid of *L. officinalis* x *L. latifolia* Vill.), the latter having by far the highest consumption in perfumery.

Lavender is a very old, agrestic-type fragrance. In ancient times "Eaux de lavande" existed with up to 60% of lavender oil, but today the lavender group is better represented by its combination with other appropriate ingredients. As mentioned above, small percentages support the complex of bergamot and oak moss in a definite way within a great number of Chypre perfume compositions. Higher percentages are found in Fougère-type perfumes which often belong to one of the most successfully growing market segments, the men's lines.

### Fields of Application

#### *Men's Lines*

Today, it is hard to find modern men's lines without a lavender top note in skillful combination with other natural or synthetic perfumery raw materials attributing freshness in a virile manner. Some of the most famous eaux de toilette are Azzaro pour homme with a distinct lavender top note, Brut (Fabergé) where the lavender note is combined with anise, lemon, sweet basil and bergamot notes, Captain (Molyneux) or Grès Monsieur Sport both exhibiting a combination of lavender with bergamot. The same complex is blended with armoise in the top note of Jules (Dior).<sup>2</sup>

Classics like Paco Rabanne or V by Victor introduced to the European market at the beginning of the 1970s are still listed in top sales ranks. Also Sir-Champaca (4711) and Wild Country (Avon) owe their fresh top notes to lavender. The trend to modernize Fougère themes cannot be overlooked: Trussardi Uomo introduced in 1984 is an evolution of the Van Cleef & Arpels theme from 1978, showing up with a very masculine leather variation in the background after starting with lavender, bergamot and basil.

In recent years it was the aim of creative perfumery to change the image of the well-known complex of lavender, bergamot and oak moss by

**Formula 1**

Ingredient	%
Lemarone <sup>R</sup>	0.5
Cumarin	1.0
Fir resinoid absolute	1.0
Orange oil Florida	1.5
Osmantinia Givco 140*	1.5
Geranium oil bourbon	1.5
Ylang-ylang extra	2.0
Oxyoctaline formate <sup>R</sup>	2.0
Musk moskene	2.0
Benzyl acetate	3.0
Benzyl salicylate	4.0
Dimetol <sup>R</sup>	4.0
Amyl salicylate	5.0
Isoraldeine 70 <sup>R</sup>	6.0
Tetrahydrolinalool	8.0
Linalyl acetate	10.0
Bornyl acetate cryst.	10.0
Lavandin Oil (French)	10.0
alpha-Hexylcinnamic aldehyde	12.0
Birch Leaf Givco 115*	15.0

<sup>R</sup> Registered trademark for Givaudan

**Formula 2**

Ingredient	%
Amber synth.	2.0
Lavender Oil (French)	3.0
Petitgrain Givco 106*	10.0
Sweet orange oil	20.0
Bergamot Givco 104*	25.0
Lemon Oil RIFM	40.0

<sup>R</sup> Registered trademark for Givaudan

**Formula 3**

Ingredient	%
Civet substitute 40/2	0.5
Eugenol	3.0
Sandalore <sup>R</sup>	3.0
Benzoin resinoid Siam	4.0
Vetiver oil Haiti	4.5
Isoraldeine 70 <sup>R</sup>	7.0
Linalyl acetate	7.0
Tree moss resinoid 50	8.0
Rhodinol 70 <sup>R</sup>	9.0
Cumarin cryst.	10.0
Musk moskene	10.0
Patchouli oil	14.0
Lavandin oil	20.0

<sup>R</sup> Registered trademark for Givaudan

**Formula 4**

Ingredient	%
Estragole	1.0
Eugenol ex Bay	1.0
Heliotropine	1.0
Benzoin resinoid 50% (sol. in dipropylene glycol)	2.0
Lemon oil Italian	2.5
2,6-Dimethyl-2-heptanol	3.0
Vanillin USP 10% (sol. in dipropylene glycol)	4.0
Sandalore <sup>R</sup>	5.0
Coumarin pure	5.0
Linalool synth.	5.0
Neroli oil subst.	5.0
Linalyl acetate synth.	8.5
Lavender oil 40-42%	25.0
Lavandin oil	32.0

<sup>R</sup> Registered trademark for Givaudan

adding a great variety of other odor notes delivered via new synthetic odorants like Dihydro-myrcenol (IFF), Dimetol (Givaudan), Cyclal C (Givaudan), Stemone (Givaudan) and others. To demonstrate such a modernized Fougère, Formula 1 may act as an example.

Another very nice complex including such specialities in combination with lavender is shown in Formula 2 which represents a fresh, natural, citrus-like and fruity odor type.

Both the compositions of Formulas 1 and 2 may be useful as fragrances for a wide field of application. They show good performance not only in alcoholic solutions, but also in toiletries (e.g., bath products, shampoos), cosmetics, soaps and detergents.

In toilet soap fragrances, it is well known that lavandin oil is of considerable value whereas lavender oil alone is not. It needs a skillful blending to develop its delightful perfume, and Poucher proposed a blend with spike oil and/or geranium oil.<sup>3</sup> We have substituted the expensive geranium Bourbon oil with synthetics like Rhodinol 70<sup>®</sup> (Givaudan) to get a Fougère with strong lavender character (see Formula 3).

Formula 4 uses lavender and lavandin oil as the base for a very interesting modified lavender

\*These formulas include some new Givaudan specialties which were introduced to the market very recently as a result of analytical studies on the absolute oil of osmanthus flowers and head-space samples obtained from birch leaves exposed to the conditions of a Finnish sauna bath.

note with orange flower, spicy and woody undertones, the latter being especially marked by the addition of a woody aroma chemical like Sandalore, which might also be replaced in certain places of the world by similar products on the market or simply by sandalwood oil which is evidently more costly.

In functional perfumery, therefore, we may assert that practically all modern men's lines owe their successes to a great extent to the sophisticated complexation of lavender notes with other raw materials.

As Astra West pointed out, Drakkar Noir with its fresh aromatic and lavender top note on a strong tenacious woody background, remains in 1985, three years after its introduction, a firm favorite.<sup>4</sup> This men's fragrance has certainly influenced introductions in many other market segments.

The men's cologne Acere (Dian Dorel CFC), for instance, is built up on the Drakkar Noir theme. It is an example of the very wide acceptance for lavender-containing perfumery notes on the Spanish market. With the launching of Estivalia (Puig), we became aware that lavender notes please the Spanish consumers.

A reasonably priced new men's cologne is offered by Bourjois (Masculin Vetyver). In spite of its Tobacco analogy, the odor description of this product encompasses the words "green, woody, lavandin." In its odor facettes Hugo Boss, very recently launched from a German fashion designer for men, is another good example for the agrestic lavandin type. The same holds for Björn Borg 6-0 introduced by Romella first in Sweden and foreseen for the international market.

Last but not least, R de Capucci has seen its launching in France during the last year. This fine fragrance for men is also characterized by the tobacco analogy showing typical fresh top notes of the lavender type on a woody-animalic background.

Even in the Oriental analogy we find a great number of lavender variations. Thus, Marani, a deo-cologne of Maurer & Wirtz in Germany, and Lynx, launched last year by Elida-Gibbs in Great Britain for the same application, exhibit agrestic lavender notes.

Fabergé launched Brut 33 Musk early in 1985 on the U.S. market. The splash-on lotion has also obvious lavender-fougère notes on its Oriental spicy-musk background.

Let us now have a look at other market segments. The famous line Irish Spring (Colgate-Palmolive), a very modern Fougère, shows up with three roll-on deodorants of different fragrance types in Germany. The one mostly di-

rected into the agrestic-fresh fragrance direction is named *Taufrisch* which means in free translation "fresh as the dew on the lawn in the early morning"!

In 1985, Schwarzkopf, another German company relaunched its well-known deo-series *Frottée* in Austria with new fragrances and packagings. The type, *Azure*, is based on a fresh lavender theme with the overall sensation of *Chypre* and woody notes.

A deodorant stick, *Sure Solid* for men (Elida-Gibbs), is new on the market in Great Britain and has an agrestic *Fougère* theme as fragrance.

The recently launched deo-spray, *Play-Boy* (Monange, Brazil), comes in two fragrances, *Special* and *Sport*. We note the presence of lavender notes in both and find a renewal of the *Paco Rabanne* theme. *Valeur pour homme* (Spectrachim, South Africa) is another variation of this successful fragrant old-timer, now applied to a 1985 aftershave.

### *Bath and Shower Products*

*Mussvital* (Peróxidos Farmacéuticos, Spain) is another example in which the Spanish toiletries and cosmetics market honors the presence of lavender/lavandin as an attracting fragrance component. *Valeur Aloe Vera* is very striking with respect to the lavender odor contribution to the whole product range of foam bath, bath oil and body moisturizing fluid. The talcum powder of the same company also exhibits a fragrance based on lavender notes.

In 1985 Boots launched *Country Herbs* in the series of their tonic bath salts. The green-aldehydic theme is supported by lavender-agrestic nuances.

The shower-gel *Dusch-Das*, associating the renown of the series "*Bade-Das*", was a line extension of Beecham for their Swiss market. Here, we find the agrestic lavender top note on a musky background. *Istrilene* (Distrilène, Belgium) is a shower-gel for body and hair: fresh agrestic top notes are well combined with woody-animalic basic notes. Another in wide use is *Blue Stratos* of Shulton. We recognize here a *Fougère* theme in combination with citrus-spicy and musk fragrances. The line includes men's *EdC*, shampoo, shower-gel, talc and deo-stick. Also of the same company which must be mentioned, *Insignia* has a fresh-floral lavender complex as the fragrance promoter of the complete line for skin and body care.

### *Hair Care*

The hair care market has recently seen the introduction of some new shower foams by Elida-Gibbs in Germany: *Impulse-Dusch Bel-*

*flair* has a citrus, green, agrestic and floral fragrance which leads to suspect the presence of one or another lavender material.

Also the line extension of Procter & Gamble's *Head & Shoulders* shampoo for different hair types is based on green, agrestic and floral ingredients for the fragrance. The same holds for a new toiletry product, *Doppel-Dusch-Naturfrisch* (Beiersdorf), once again an evolution of the *Drakkar Noir* fragrant theme. Very typical lavender-agrestic aspects are observed in *Waitrose Family* put on the market in Great Britain by Waitrose.

The *Gillette Good News* shampoos just went on the U.S. test market in 1985. They are all based on *Fougère* notes in which lavender naturally plays an important role. Lavender as an integral part of the fragrance appears also in the baby shampoo *Goupil* in Spain. Even in the Far East, new market introductions like *Soft'n Shiny* (Colgate, Malaysia) follow the lavender path.

### *Toilet Soaps and Detergents*

In the field of toilet soaps let me mention the new introduction of *St. Michael-Forest Fern* by Marks & Spencer in Great Britain. A very typical *Fougère* in its own, it is combined with a distinct floral-rosy note.

*Lux Luxo*, a toilet soap introduced by Gessy Lever in Brazil, constitutes a relaunch with a new fragrance based on green-floral, citrus-like and agrestic odor notes. The lavender character is once again more pronounced in the *Palmolive Suave* (Colgate-Palmolive, Brazil) toilet soap.

New detergent fragrances have a good deal of lavender facettes in their olfactory profile, accompanied by green, floral or fruity aspects. *Gamma plus* (Colgate-Palmolive), *Orchid* (Formosa United), *Pao Bun Jin* (Lion Corp., Thailand) and *Sulfo* (Nordtend, Sweden) show that the freshness and cleanliness of the lavender fragrance complex is well accepted all over the world. The *New Tide* (Procter & Gamble) indicates that *Fougère* notes also are undergoing a renewal in powder detergents.

In the range of liquid detergents, *Sole Blue* (Panigal, Italy), exhibiting a strong lavender fragrance combined with fruity undertones, has been seen for the first time on the Italian market in Spring 1985. *Fraîcheur Lavande*, a concentrated fabric softener in the *Minidou*-series (Lesieur-Cotelle), came out at the same time in France. It bears directly the name of its most important fragrant ingredient.

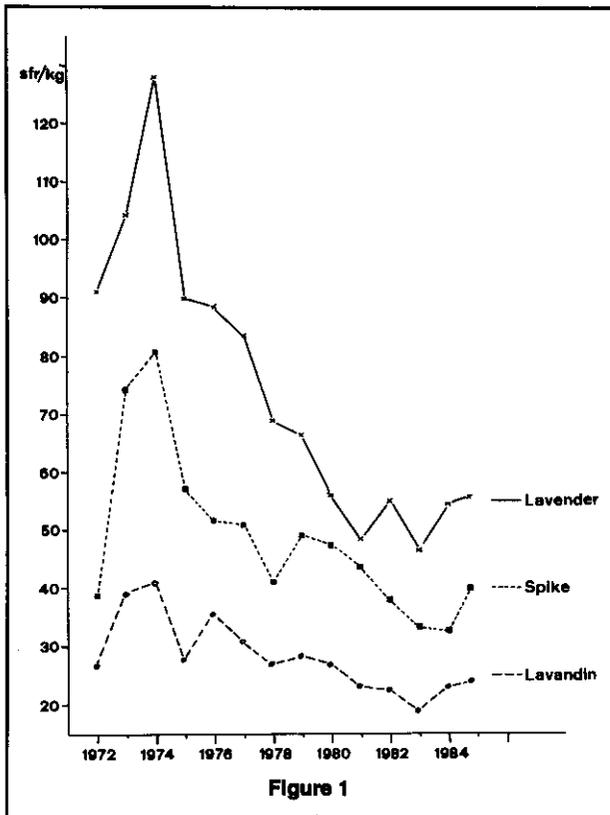
The same can be said of some recently launched household products like the air-freshener *Fleur Air-Lavanda* (Snia Casa, Italy).

## Perfumery Notes—Lavender

The freshness inherent to all lavender notes makes such fragrances a first choice especially in air-fresheners (Elektro Frischluft Deo from Globol-Werke, Germany), in dish-washing liquids (Minerva Limao from Gessy Lever, Brazil) or even in scouring products (Mr. Clean from Procter & Gamble).

### Essential Oil Group

We have seen that the lavender group, although utilized for centuries in perfumery, continues in a rejuvenated or modernized form on top of the perfumers' preferred products. This permanent success is well reflected by the annual production capacity which is estimated by B. M. Lawrence to be around 200 tons for lavender oil and 750 tons for the three types of lavandin oils in 1984.<sup>5</sup> Interestingly enough, Bulgaria has surpassed France in production of lavender oil during the last twenty years.



With the shortages in the early seventies, perfumers were suddenly confronted with price increases (*figure 1*) not tolerable in the field of mass market applications. At this time, it became clear that substitutes or—with a better word—reconstitutions must be able to fill in exactly the olfactory gaps opened with the omission of the natural substrate in a fragrance composition. The first step in this direction was the in-depth analysis of the oil to gain sufficient knowledge

Table I: Average Concentration (In %) of Some Constituents of the Lavender Group Oils

	1	2	3	4	Camphor	1,8-Cineol	Caryophyllene
Lavender	31.7	38.2	0.7	3.0	0.4	0.9	4.0
Lavandin	32.0	26.0	0.5	1.4	9.3	8.2	2.3
Spike Lavender	40.0	<0.1	0.1	trace	14.2	26.0	0.8

about its qualitative and quantitative composition. All major companies of the fragrance industry initiated such analytical programs to become independent of the logistic bottlenecks hampering their creative perfumers, their cost calculation and their capabilities to act as reliable suppliers of fragrance compositions.

A great advantage at this time was the availability of the main components, linalool 1 and linalyl acetate 2. Big manufacturers were at hand for these commodities. It goes without saying that both substances alone do not furnish a lavender or lavandin substitute, even when mixed in the appropriate ratios as found in nature.

The plant produces and its essential oil therefore contains other very specific substances from which the lavandulol 3 and its acetate 4 should be mentioned first. Their names already indicate a relationship to their occurrence in the specific natural substrate.<sup>6a,b</sup> They show an irregular monoterpene skeleton, i.e., a non-head-to-tail linkage of two isoprene units. Their availability by synthesis, at least on a semi-industrial scale, was summarized by W. Hoffmann.<sup>7</sup>

Our own analyses of a great number of essential oil samples have shown the following average concentrations as the most typical ones for compounds 1-4 as well as some other significant main components which permits the differentiation between lavender, lavandin and spike lavender oils.

Moreover, a great number of minor constituents play an important role for the total olfactory impression. Interesting relationships could be found in a series of bifunctional derivatives of 2 and 4, thus offering some hints with regard to their formation in the plant cells.

### Special Constituents and Their Formation

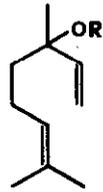
Bifunctional compounds such as epoxylinalyl acetate 5 and the hydroxylated derivatives of linalyl acetate (6 and 7) were first described by B. D. Mookherjee and R. W. Trenkle as constituents of lavandin oil.<sup>8</sup> Later on, R. Kaiser and D. Lamparsky<sup>9</sup> confirmed their presence also in lavender oil, together with the keto esters 8 and 9.

The first hydrolylated derivative 11 of lavandulyl acetate was detected by J. C. Belsten et al. in lavandin oil.<sup>10</sup> We found compound 10 in the same natural substrate whereas compounds 12-14 were detected in lavender oil.<sup>9</sup> Compounds 11 and 12 exhibit a floral-herbaceous but relatively weak odor. The ketones 13 and 14 show more fruity nuances on a herbaceous background. It is not astonishing that also these compounds as bifunctional, higher-oxygenated derivatives are weak in odor but may nevertheless be constituents which round off the over-all aspect of a good lavender oil. All these components are shown to be biogenetically related to linalyl acetate or lavandulyl acetate, respectively via a photooxidation-type reaction sequence.

For a long time sesquiterpenes other than some hydrocarbons resisted detection in lavender oil. However more recently analytical chemists were able to identify a number of derivatives with a santalene skeleton.<sup>9-11</sup> It seems that the formation of compounds 16-19 may be explained by the same biogenetic pathway as just mentioned for the derivatives of linalyl acetate or lavandulyl acetate. Photooxidation of (-)- $\alpha$ -santalene 15—this parent hydrocarbon in lavender oil shows the opposite sign in its optical rotation when compared to the (+)- $\alpha$ -santalene occurring in sandalwood oil—delivers first  $\alpha$ -photosantalols A (16) and B (17). The odor of photosantalol-A is reminiscent of the well-known corresponding  $\alpha$ -santalol which is described by Arctander as being sweet, warm, woody and tenacious. Further oxidation of 16 furnishes the ketone 18 exhibiting a fruity-woody odor like its hydrogenated derivative 19. An intermediate epoxide could not yet be detected in this series.

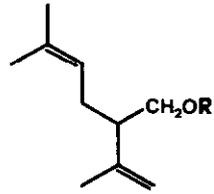
However, the possibility of the formation of epoxides on trisubstituted double bonds of sesquiterpene hydrocarbons in lavender oil is well documented in the series derived from (-)-caryophyllene 20 which represents one of the main components in this oil.

Caryophyllene epoxide (21) and isocaryophyllene epoxide are already known from the work of R. J. Steltenkamp and W. T. Casazza.<sup>6b</sup> The isomerization of the trans- to the cis-config-



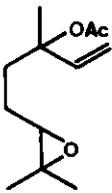
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2 (R=Ac)

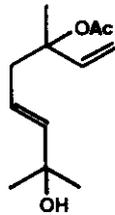


3 (R=H)

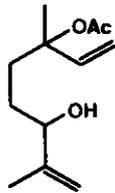
4 (R=Ac)



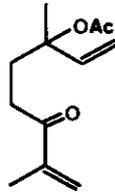
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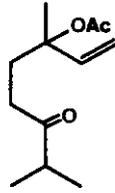
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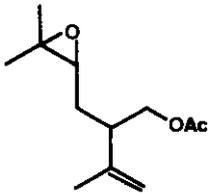
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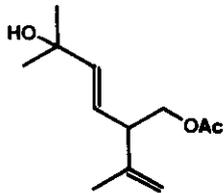
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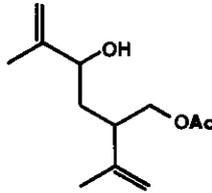
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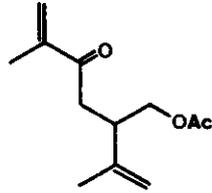
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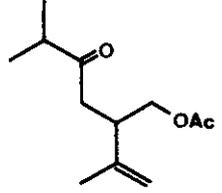
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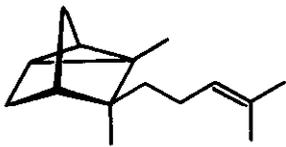
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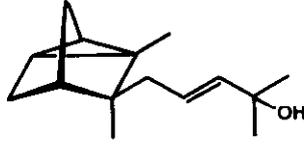
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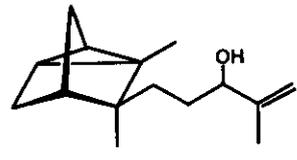
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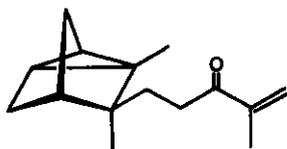
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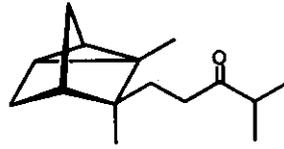
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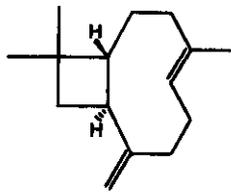
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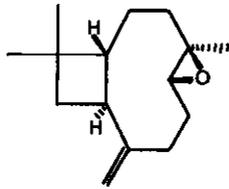
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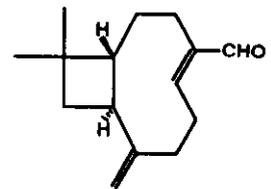
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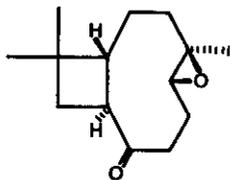
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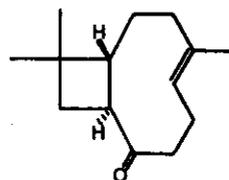
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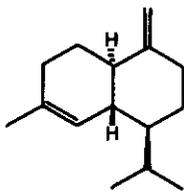
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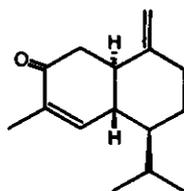
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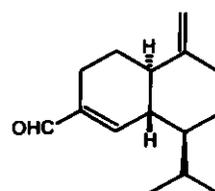
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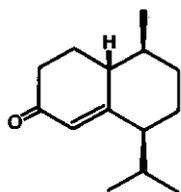
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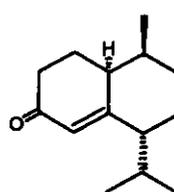
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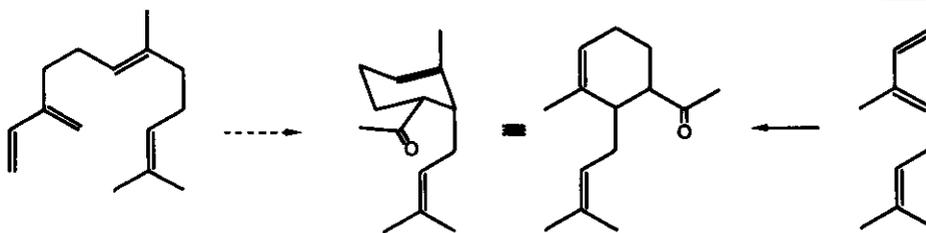
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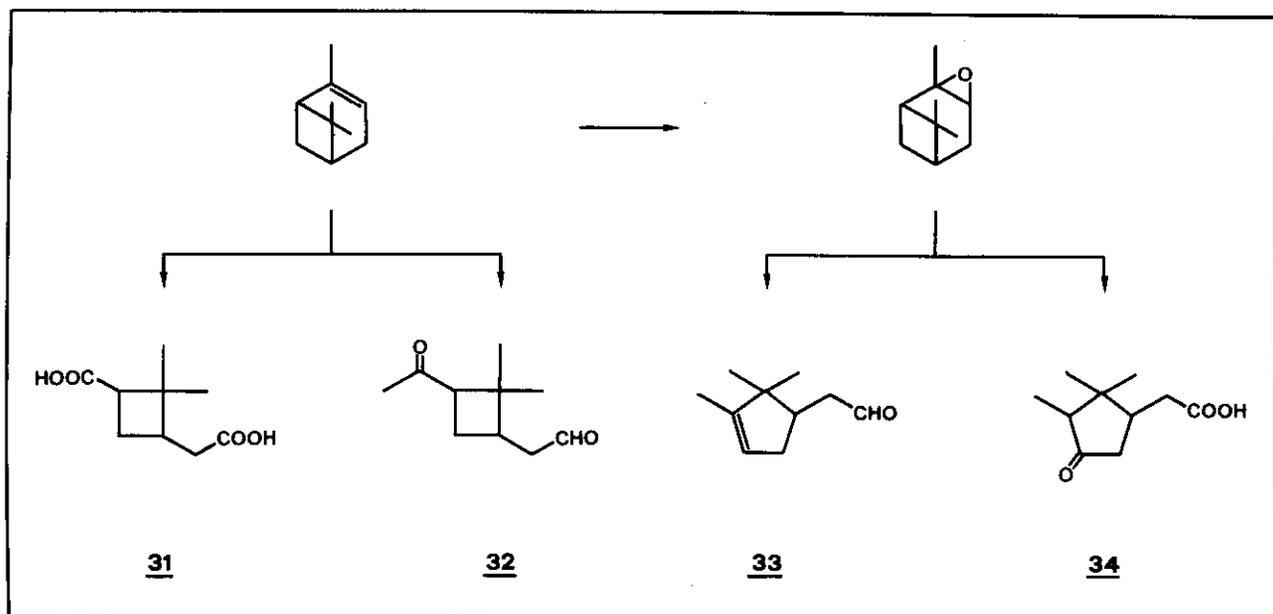
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urated double bond in the large ring indicates once more the possible influence of light during the formation of odorant molecules in the plant cells. Compound 21 gives rise to an epoxide ring opening followed by oxidation of the secondary alcohols to the corresponding allylic ketones which we detected in the high-boiling carbonyl fraction of lavender oil together with the aldehyde 22 and the nor-sesquiterpenoids 23 and 24 as trace constituents.<sup>12</sup>

Oxidative transformations of the same type, i.e., the formation of  $\alpha,\beta$ -unsaturated ketones like 26 or aldehydes (27) within the existing C-15 framework or a degradation to nor-ketones could be observed in the cadinane series by several authors.<sup>8,11</sup> The structural proof for compounds 28 and 29 was finally given by synthesis from menthone and careful inspection of the 400 MHz-<sup>1</sup>H-NMR spectra. Compound 28 exhibits a floral, green and herbaceous odor complex.

Much more important for certain olfactory notes in the background of lavender oil should probably be some Diels-Alder addition products like compound 30 which was first discussed by a research team of Roure-Bertrand-Dupont as a new nor-sesquiterpene ketone.<sup>13</sup> This cyclohexene derivative is identical with the so-called compound 21A mentioned in the publication of B. D. Mookherjee and R. W. Trenkle on new constituents of lavandin oil.<sup>8</sup> Later on, the nature of a real Diels-Alder adduct from ocimene and vinyl methyl ketone was clearly corroborated by our detecting other components which originate from diolefinic hydrocarbons like ocimene, myrcene, farnesene or undecatriene and  $\alpha,\beta$ -unsaturated ketones present as such in lavender oil.<sup>14</sup> All these products are really naturally oc-

curing substances because we were able to detect them even in a freshly prepared hexane extract of lavender blossoms. Due to their low vapor pressures most of the mentioned Diels-Alder-adducts do not retain the immediate interest of a perfumer. But we believe that even the faint green-herbaceous notes which adhere to them would play a role in lavender not to be overlooked when regarding the total odor impression.

Let us once again return from the high-boiling components to the more volatile products. As we have seen, oxidative processes are often responsible for the occurrence of minor constituents having a carbonyl group as osmophoric group in their molecules. In summary, the double bond systems in the mono- and sesquiterpene structures offer enough possibilities for an attack of oxygen. Therefore it is not astonishing to notice several oxidation or degradation products in the light of our essential oil group. The linalool oxides occur in all three items, whereas the 2-methyl-2-vinyl-5-isopropenyl tetrahydrofuran could only be detected in lavender oil.

A series of lactones was described by R. Timmer et al.,<sup>15</sup> and one can imagine linalool as the precursor for several of them. Another precursor of such degradation products is  $\alpha$ -pinene which affords not only the virtually odorless pinic acid 31, but also pinonic aldehyde 32 with a pleasant odor facette. Especially spike lavender oil contains these trace components as pointed out by D. de Rijke et al.<sup>16</sup> The same authors described furthermore the presence of  $\alpha$ -campholenic aldehyde 33 together with the corresponding carboxylic acid and its  $\gamma$ -isomer as well as the oxo acid 34. The rearrangement of  $\alpha$ -pinene epoxide

to the aldehyde 33 is a well-known process occurring in nature and now industrially used for the production of new odorants like Bacdanol (IFF), Sandalore (Givaudan) and Brahmanol (Dragoco).

To summarize the analytical work, today we can ascertain the really impressive number of more than three hundred constituents occurring in the natural lavender substrates. The high perfumistic interest in these oils is well reflected by such a tremendous effort in investigating the chemical compositions. To find out the really necessary substances for a good reconstitution—the goal of this effort—a close cooperation of analytical chemists and perfumers is now a prerequisite. In reconstitution work perfumers act like flavorists because they must reach the natural odor pattern with high fidelity. No creative fantasy as used in the compository work of high-class perfumes, but a tedious, often time-consuming testing of all the constituents elucidated by the analytical chemist and afterwards prepared synthetically by working colleagues is required for such teamwork.

At the end of this busy time when substances cannot be produced with reasonable yields or costs, we may need recourse to the imagination of the perfumer. The lack of availability of certain compounds offers a real challenge in order to finally end up with a successful reconstitution.

### Outlook

We have now learned that, especially in functional perfumery, the group of lavender, spike lavender and lavandin oils has the same importance today as yesterday. One cannot imagine a modern men's line without having a lavender note in it. On the other hand it is very typical that we do not have a similar strong establishment of lavender in the feminine fine fragrances. The cases are rather rare in which we may identify agrestic notes possibly related to the use of lavender oil—in spite of its floral aspects.

We may deduce from this that, at least at present, the agrestic lavender notes always belong to the more virile fragrance composition themes, but let us not forget some "unisex" perfumes in which lavender certainly also plays its part. Of further interest is the endeavour of some companies to relaunch successful fragrances of the past. Normandie (Jean Patou) is such an eau de toilette exhibiting agrestic nuances on a spicy Oriental background. In a variation of the theme of Eau Sauvage, we could also recognize agrestic facettes besides the basic floral notes in a splash cologne for women issued last year in Argentina under the name of Gelatti Glacial (Federal).

Yet another perspective may be opened by an interesting patent publication in which the effect of lavender oil is claimed to block the smell of L-menthol in dosages up to 3% by weight.<sup>17</sup> Tonic shampoos, hair rinsers or body lotions thus provide a cool feeling to the skin but hide the typical odor note of the main ingredient of peppermint oil when combined with lavender oil in a ratio from 1:3 to 2:1.

In summary, the prospect for lavender notes in perfumery is bright. Personally, I am convinced that we will see once again a more sophisticated application of them in all sectors of perfumery. New research chemicals will enter the perfumers' shelf thus contributing to a constant modernization of the old lavender fragrance, especially in supporting its cleanliness aspect. Perfumers as well as chemists should therefore be curious enough to look on the market for such introductions which may be the success of a tomorrow's briefing.

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