Bulgarian Lavender and Bulgarian Lavender Oil

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Until about 1965 Bulgaria was known to international perfumery circles for its top quality rose oil and by the famous oil of **Mentha piperita**, type Bulgaro-Mitcham.

The post World War II technical modernization and organization of the economy have influenced in various ways the traditional Bulgarian cultivating of aromatic plants and their processing to products for the perfumery. For instance, in spite of the high production costs and the severe competition on the part of some other farm products (such as maize, corn, grapes, tomatoes and other fruits and vegetables), Bulgaria succeeded in preserving unchanged one of its national symbols, the Bulgarian Rose Oil. It has been preserved thanks to age-old traditions, to strict observation of the technology, persistent and careful quality control, the Government's concern and the extremely high international praise for the oil.

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On the other hand the production of the peppermint oil Bulgaro-Mitcham type was negatively affected. The annual production of 220 t for 1957 has been reduced to 8 t at present; at the same time its future is not clear due to the obvious economical disadvantage of its production. Instead of peppermint oil, the Bulgarian lavender oil took the first place in amount of produced quantities.

This review attempts to trace the development of the lavender culture and the production of lavender oil in Bulgaria, to reflect their present states and the expected changes for the next 10-15 years. At the same time it tries also to give a possible impartial assessment for the quality of the oil. Besides his own results about the chemical composition of the Bulgarian lavender oil, the author uses widely the numerous published and nonpublished information of many Bulgarian specialits, as well as the official business data and reports. Unfortunately, only a small part of the published reports are included in the References as the greatest part of them have been published only in Bulgarian and in editions with a restricted distribution. Some data about foreign types of lavender oil may assist the reader to determine the place of the Bulgarian lavender oil among the other types.

Lavender in Bulgaria to 1945

The botanical genus *Lavandula* with its numerous species and varieties is not known among the Bulgarian flora. The first experiments for lavender cultivated in Bulgaria date as far back as 1903. Seedlings with a characteristic unknown today were imported from France and, together with some other aromatic plants, were planted in a small assortment plot in the Experimental Station for Aromatic Plants (the present Research Institute for Roses, Aromatic and Medicinal Plants) near Kazanlik in the Bulgarian Rose Valley. In the course of two decades the plants were completely neglected. Only in 1925, a few occasionally found half-dead lavender plants, as well as seeds (also with a characteristic unknown today) additionally imported from France and England, were used for systematic cultivation experiments and for production of oil. The strong polymorphism of the lavender, its degradation in the reproduction through seeds, the environmental influence, as well as the large variety of the original planting material, led during the next decades to plantations with a broad mixture of plants, for instance, with blossoms coloured from pure white to dark violet.

Until the end of World War II the production of lavender oil was very limited and irregular due to the economical disadvantage for the farmers—about 150 kg totally per year for the period from 1935 to 1942. After the war its production was increased gradually; from 450 kg for 1949 it reached 10 t in 1958.

New lavender fields ensuring the necessary plant material have been created both by qualified agronomists and by the initiative of single farmers. Both vegetative and seed-reproduction of materials selected from the lavender generation of 1903 and 1925-1926 had been used. The further uncontrolled cross-pollination of the plants followed by biological degradation of the offspring gave a strongly heterogenous lavender population. It bears the basic characteristics of its unknown predecessors additionally influenced by specific environmental factors and by chance or purposeful human intervention.

Lavender in Bulgaria after 1945

Excepting the common physicochemical characteristics, it is very difficult now to give additional specific data about the lavender oils produced in Bulgaria from 1935 til 1950. The ester contents (as linalyl acetate) used at that time as a basic characteristic for evaluation of the quality of the oil has been of very low value (30%) and the fragrance is not specific for a typical lavender oil. With the view of improving the quality of the oil, a systematic study started in 1950, accounting the influence of all factors of importance—technological, ecological and agrobiological. A good review on the Bulgarian lavender oil, reflecting in part these results, was published in 1959 in Bulgarian.[1]

The distillation of the lavender blossom has been improved by changing distillation from water-steam to dry-steam[2] in vessels made of well-tinned copper or of stainless steel. It particularly increased the ester contents of the oils by 5-10%, and considerably improved the aroma. Some technical improvements have been also introduced in the distillation stills and their optimal operating levels have been established, i.e., the quantity of blossom per cubic meter of the vessel volume, and the rate and the length of the distillation process. The transportation and the storage of the harvested lavender have also been improved, which reduced the changes in the oil caused by evaporation, moulds and fermentation of the flowers. Oils obtained from plantations of various sub-areas in the Rose Valley were evaluated by accounting the influence of the altitude, the soild composition, air and soil moisture, sunshine, winds, rainfall, temperature and other environmental factors.

The accumulation of the oil in the lavender flowers and its quality at the various stages of the blossoming were investigated too. It was established that the harvest should start after blossoming out of half of the flower buds in the lavender racemes (50% blossoming) and should terminate prior to the end of the blossoming.[3]

For selection purposes a large number of the polymorphous varieties were specified in the population and their oils were evaluated. The planning of the new plantations and the technics of the vegetative reproduction were considerably improved.[4]

In spite of good practical results, the quality of the Bulgarian lavender oil of that period, however, still remained at a medium level because of the determining role of the biological specificity of the already spread out local lavender population. The characteristics of the oil reflected by the first Bulgarian State Standard of 1951 for lavender oil, as well as the next Standards of 1960 and 1973 are given in Table I.

The indices, required by the Standard (Table I) refer only to the decanted lavender oil. They show a gradual improvement of the quality for a period of more than twenty years, mainly considering the increased ester content and the lower value of the optical rotation. At the same time the olfactory evaluation was improved, too.

The first detailed investigation of the individual chemical composition of the Bulgarian lavender oil was carried out with a production sample of 1964.[5] By means of a combination of precise laboratory rectification, preparative chromatography on alumina, gas-chromatography, IR spectra and chemical methods, a number of compounds already known for lavender oils of French origin were identified, such as:

Table I. Characteristics of the Bulgarian Lavender Oil according to the Bulgarian State Standards of 1951, 1969 and 1973

Indices	1951	1969	1973
Appearance	mobile pale yellow, clear liquid		
Odour	specific for lavender oil		
Specific gravity at 20 degrees	0.881-0.904 (15°)	0.876-0.899	0.876-0.892
Refractive Index at 20 degrees	1.460-1.470	1.460-1.469	1.460-1.469
Optical Rotation, (100 mm at 25 degrees C)	-1° to -10°	-2° to -10°	-3° to -10°
Acid Number, less than	1.0	1.0	0.8
Esters, in %, (as linalyl acetate), minimum	33	34.1	35
Water content	none	none	none
Solubility (in ethanol), minimum	1:10 (70%)	1:2 (75%)	1:2 (75%)

α-pinene, camphene, β-mycrene, limonene, ocimene, cineol, p-cymene, α-terpinene, octanone-3, *l*-linalool, d-terpinene-4-ol-1, *l*-linalyl acetate as well as small amounts of other esters. One of them, wrongly shown as isogeranyl acetate, later was corrected as lavandulyl acetate.[6].

In a similar way the sesquiterpene hydrocarbons β-cariophyllene, α-santalene, ar-curcumene, γ-cadinene, δ-cadinene, bergamotene and farnesene have been identified in the residue after removing in vacuo of the monoterpene fraction of 140 kg oil.[7] The gas chromatographic analysis, combined with a preparative isolation of individual compounds, established[8] that the terpene oxygen-containing compounds in the monoterpene fraction of the decanted oil come to 85% while they are up to 99% (Table II) in the cohobated oil (produced in limited quantities for technical purposes only).

Table II. Chemical composition of decanted (I) and cohobated (II) Bulgarian lavender oil of 1970 (in % for monoterpene fraction)

Components	I	II
Cineol + octanone-3	4.4	6.6
Limonene	7.1	< 0.5
Myrcene + ocimene + delta-terpinene + p-cymene	5.7	0.6
Linalool	25.5	34.8
Linalyl acetate	32.1	< 0.5
Terpinene-4-ol-1	14.9	42.6
Borneol	1.5	13.7
alpha-Terpineol	1.8	0.6
Geraniol	1.1	1.3
Geranyl acetate	1.8	< 0.5
Lavandulol and acetate	2.8	< 0.5
Optical Rotation alpha-D$^{(100\ mm)}$	- 4°	5°

These data about the composition of the Bulgarian lavender oil are valid for the period of 1960-1970 for the local population. The content of linalyl acetate in the oil was comparatively low (20-25%) while the esters were at a total of 32-35%. Like some other types, that Bulgarian lavender oil contained camphor below 1% and the ratio of linalyl acetate: linalool was above 1. The relatively high content of (+)-terpinene-4-ol-1 was specific for the lower value of the optical rotation as well for some side and nonspecific olfactive notes.

This typical chemical composition of the oil of the population shows unambiguously that the improvement of the quality should be sought, first of all, in the reduction of the contents of terpinene-4-ol-1 and the increase of the linalyl acetate. For this instance, during the period 1965-1975 a broad programme of technological, environmental and cultivating studies were carried out.

The basic results indicated that no one of these ways led to a considerable improvement in the chemical composition of the oil produced from the population, as the composition itself is a result mainly of the generic specificity of the plants. This conclusion underlines the absolute necessity of improving the plantations through replacement of the local population by more suitable plants either breeded in the country or imported from abroad. The results of the large-scale ecological and agrobiological studies on the local population were also very useful in creating and maintaing the new lavender plantations.

Improvement in the Lavender Plant Variety

The most important aim of the improvement of

the lavender plantations was to raise the quality of the oil and, at the same time, to increase the production volume. The goals were set:

- increase the yield of oil per kg of flowers and per hectare
- create larger homogenous fields with simultaneously growing plants, suitable for mechanized cultivating and harvesting.

The worldwide experience shows, however, that any increase in the oil content of the lavender blossom over a certain level debalances the chemical composition of the oil and decreases its fragrance. On the other hand, relying on their long observations of the French lavender, Vinot and Bouscary give an explicit warning about the aggravation of the flavour if the natural heterogenous lavender population were replaced by a few highly productive but well leveled and homogenous clones.[9]

Therefore, the rational development of the lavender oil production in Bulgaria was bound with the introduction of lavenders giving a moderate yield of oil (20-40 kg per hectare), with a low content of terpinene-4-ol-1, cineol and camphor, with 40-65% of esters and well adapatable to the local environment. Of additional but significant importance are, for example, the habitus of the plants suitable for mechanized cultivating and harvesting and the availability of early-middle- and late-blossoming varieties in order for the period of the harvesting and the distillation of the flowers to be extended.

The plantation of the local population located mainly in the Rose Valley around the towns of Kazanlik, Karlovo and Klisura have been used as a good source for collection of individual plants and for selection of clones. In the course of many years, several working teams (Institute of Plant Physiology at the Bulgarian Academy of Sciences, Research Institute for Roses, Aromatic and Medicinal Plants, Higher Agriculture Institute-Plovdiv, agronomists to the "Bulgarska Rosa" Works, to the State Agrarian-Industrial Complexes and the Co-operative Farms) have carried out thousands of experiments and observations on the plants collected from the population and on their vegetative and seed generations.[10-15] As a result, about twenty prospective clones have been selected, among them being "Kazanlik," "Karlovo" and "Hemus" (authors: V. Staikov, B. Chingova, H. Chorbadzyiski), "Aroma" and

Table III. Characteristics of lavender oils from eight experimental plant varieties (average values for 1973-1977 per 7 regions) (reference 18)

	% Esters	Linalool	Linalyl Acetate	Terpinene-4-ol-1	I	II
1. Stepnaya (USSR)	53.0	23.5	37	6.3	1.6	9.7
2. Gornaya (USSR)	50.0	17.0	24	5.1	1.4	7.9
3. Prima (USSR)	77.0	16.0	53	3.9	3.4	17.7
4. Record (Bulgaria)	58.0	19.0	38	4.6	2.0	12.3
5. Hemus (Bulgaria)	62.0	24.5	41	3.8	1.7	17.3
6. Karlovo (Bulgaria)	58.5	26.0	40	3.5	1.6	18.7
7. Kazanlik (Bulgaria)	57.0	26.0	39	6.1	1.5	10.6
8. Population (Bulgaria)	45.5	24.0	28	9.8	1.2	5.3

I. Linalyl acetate:linalool

II. (Linalyl acetate + linalool):terpinene-4-ol-1

Table IV. Characteristics of lavender oils from three-year-old varieties

	% Esters	Ocimen	Cineol	Linalool	Linalyl Acetate	Terpinene-4-ol-1	I	II
1. Stepnaya	47	13	1	29	30	6.1	1.1	9.7
2. Gornaya	44	10	19	16	24	4.5	1.5	8.7
3. Prima	69	7	4	19	42	3.3	2.3	18.3
4. Record	49	16	5	24	26	4.1	1.1	12.3
5. Hemus	60	11	4	26	38	3.3	1.5	19.6
6. Karlovo	50	4	9	26	34	3.4	1.3	17.5
7. Kazanlik	53	7	3	22	41	5.2	1.9	12.2
8. Svejest	50	6	3	26	29	8.0	1.2	7.0
9. Aroma	56	5	9	28	35	3.8	1.3	16.3
10. Population*	45	9	3	24	28	9.8	1.2	5.3
11. Sample "A"	48	8	6	22	33	6.3	1.5	8.7
12. Sample "B"	54	6	5	24	42	5.8	1.7	11.4

I. Linalyl acetate:linalool

II. (Linalool + linalyl acetate):terpinene-4-ol-1

* Experimental plot

"A" and "B" - Commercial French oils type Barreme

"Svejest" (El. Dimitrova), which attained an economical importance about 1978-1980.

Together with the clonal selection based on the local population, in 1963-70, an intensive study was carried out with imported seedlings of French and Soviet lavenders.[10-16] From these imported materials and their vegetable generations, by 1978-1980 economical importance was attained by only the Soviet clones "Stepnaya," "Prima" and "Record" while all others were rejected due to the lower quality of the oil or to their incompatibility with the local environment which led to generative changes after the third or fourth year from the planting. Special attention was devoted to the discovery of sub-regions with suitable soil and climate conditions. The detailed gas-chromatographic analysis of oils from some sub-regions were published in 1976.[18]

As a result, by 1980 the local lavender population has been replaced to 70% by the new clones. Large plantations have been created out of the Rose Valley too. The clones together with the intentionally preserved part of the local population contributed almost equally to the general plant composition of the plantations. The average indices of the oils produced during the experimental cultivation of the new lavenders in the course of five years and in seven various regions are given in Table III.[19]

The quantities of the main components in oils, produced from three year old lavender clones grown on experimental plots (40 plants per 31 m^2,

each clone in fourfold repetition), located in the area of the village of Dragomir, district of Plovdiv, are shown in Table IV.[20]

The contents of camphor in all oils indicated in Tables III and IV come to less than 0.5%. The data of 1977 on two commercial samples of French oils "Barrême" type are also indicated in Table IV for comparison. The gas chromatographic analysis has been carried out with a column of 2 m length and inner diameter of 4 mm, filled with Chromosorb-W impregnated with 10% PEGA (Polyethylene glycol adipate); the quantity of each component has been evaluated in percent of the total area of the peaks by means of a computing integrator.

In this way, these nine types of lavender recently cultivated in Bulgaria (8 clones and the local population) allowed the production of large lots of lavender oils with certain differences in their composition and odour. This is in conformity with the already mentioned general view of Vinot and Bouscary considering the plant variety of the lavender plantations. The introduction of these oils on the international market, either in individual lots or after blending them in an appropriate way depends both on the professional qualification of the specialists at the main factory of "Bulgarska Rosa" and on the specific requirements of the customers and perfumers.

Production Regions and Plant Variety in 1980

One of the essential results of the biological and ecological studies on the Bulgarian lavender was the discovery of other regions, out of the Rose Valley, suitable for lavender cultivation. These are some village areas near the towns of Shumen and Varna in northeast Bulgaria and near the town of Vidin in the remote northwest of the country. In these new regions, the complex of environmental factors (the structure, composition, alkalinity and moisture of the soil, the altitude, exposure to sunshine, rainfall, wind and temperature fluctuation) proved to be suitable for lavender cultivation.

The correlation between the phenophases of the lavender and the "effective temperature" necessary for their development defined after A. A. Shipolev[21] has been used in the study of the new regions. Each phenophase (germination, budding, blossoming, etc.) starts only when, in the course of a certain number of days, the average twenty-four hour temperature remains above a required value specific for each type of plant and for each phenophase. The differences be-

tween the actual average twenty-four hour temperatures required for the development of the phase to be started, summed up for the days from its beginning to its end, is the "effective temperature" for the phase. The thermophilic plants need a higher "effective temperature;" the occasional colds or hots extend or reduce respectively the duration of the phase. The observations on the lavender carried out in Bulgaria have shown[22] that the Spring vegetation starts when the average twenty-four hour temperatures are above 7°C in the course of about ten consecutive days. The "effective temperature" necessary for the beginning of the Spring vegetation until the end of the blossoming comes up to 1200-1250°C. In the fields near the town of Kazanlik, this development of the lavender requires about 90 days.

Most frequently the lavender plantations are located on level or slightly slanting terrains suitable for mechanical cultivation. Slightly alkaline soils with low underground waters, with an altitude of 400-1000 m above sea level, with good exposure to sunshine and protection from strong winds are selected. The ground between the rows is cultivated 3-4 times yearly to control the weeds. Every year the plantations are fed with fertilizers, selected according to the chemical composition of the soil thus increasing the yields of blossoms and oil. The average yields of oil come to 18-22 kg per hectare and, only as an exception, up to 30 kg. The harvest of a new plantation starts after the second year; after 10-12 years the plants become obsolete to a great extent and are no more suitable for production of oil. Therefore, a part of the old plantations and those located too far from the villages usually remain uncropped.

One production region covers the lavender plantations of several villages. The collective farming of the land by the Co-operative Farms and by the State Agrarian-Industrial Complexes made possible the creation of large in size (50-200 hectares) single plantations, while the total lavender fields around a village are from 100 to 600 hectares. The machinery for cultivation are also in collective ownership.

The foremost place in a production region belongs to the distillation installation, which is property of "Bulgarska Rosa," the latter being a part of the State Enterprise Pharmachim. "Bulgarska Rosa" purchases the oil distilled from the farmers' own lavender at fixed prices controlled by the State.

The plant variety of the lavender plantations is responsible to a great extent for the quality of the oil of the region. Besides that, a proper combination of early-, middle- and late-blossoming varieties extends the production campaign up to 25-30 days, in spite of the fact that the period of the technical ripeness of the lavender (50-100% blossoming) lasts usually only 10-12 days. This facilitates the campaign's organization and reduces the loss of oil. A regular production region contains usually about 30% of early ("Stepnaya," "Record," "Prima"), 40-50% of middle ("Hemus," "Karlovo" and "Aroma") and 20-30% of late-blossoming clones ("Svejest" and the local population).

The harvest starts at about 50% blossoming of the racemes, around the 20th of June for the warmer regions and is completed around the 5th of August for the colder and higher fields, lasting for a total of about 25-30 days. About 40% of the blossom are collected with machines while the rest is hand-cut which considerably raises the cost of the production. The collected blossom is transported in bulk by trucks to the local distillery, normally not farther than 50 klm from the plantations.

During the same period a number of experiments have been carried out on lavandine clones imported from France. In spite of good results the cultivation of lavadine in Bulgaria has been suspended in order to protect the Bulgarian lavender oil from suspicion of a casual or deliberate blending with lavandine oils.

Production, Evaluation and Storage

The harvested blossom is subjected to distillation as soon as possible upon its delivery to the installation. Distillation stills of well-tinned copper or of stainless steel, with 5-10 t capacity are used. The distillation is carried out only with direct steam produced in a separated boiler and is completed in less than 90 minutes. The oil is removed from the water with Florentine-type separator. Then it is subjected to dehydration with anhydrous sodium sulphate and after filtration is stored in zinc-coated iron barrels. Each barrel containing 200 l of oil represents an individual "micro-lot" and its composition and flavour depend on the local factors, i.e., the lavender variety, soil, age of the plantation, stage of blossoming, hour and meteriological conditions during the harvest day, and storage of the blossom before the distillation.

During the peak-time of the season two shifts or around-the-clock work at the distillery is en-

Table VI. Characteristics of the new brands of the Bulgarian lavender oil according to the Bulgarian State Standard 1980

	Hemus	Kazanlik	Karlovo	Svejen
Appearance		clear mobile liquid		
Colour		pale yellow		
Odour	a	b	c	d
Specific gravity	0.878-0.888	0.876-0.892	0.876-0.892	0.876-0.892
Refraction Index	1.457-1.465	1.460-1.469	1.460-1.469	1.460-1.469
Polarization (100 mm)	-5° to -10°	-3° to -10°	-3° to -10°	-3° to -10°
Acid Number, less than	0.8	0.8	0.8	0.8
Esters, in %, (as linalyl acetate), minimum	50	42	42	38
Solubility (in 75% ethanol), less than	1:2	1:2	1:2	1:2

	Odour
Top Note	Middle Note
a. light, fresh, with sweet note	dense, sweet-floral
b. fresh, of lavender	warm, dense
c. of lavender with fatty notes	warm, dense
d. of lavender with terpene notes	dense, with fatty notes

Table VII. Esters (in %) and the relative share, in %, of lots of oils with different ester level* (average data for three regions, 1977 and 1981, according to "Bulgarska Rosa")

	Zelenokovo		Dabene		Grozden	
	1977	1981	1977	1981	1977	1981
Esters in % for the year	46	47	42	44	47	48
Oils (in %)* with esters below 40%	24	16	26	10	3	0
Oils (in %)* with 40-50% esters	58	39	74	75	84	70
Oils (in %)* with esters above 50%	18	45	0	15	13	30

* After the analysis of each barrel
(See section in text on "Production, Evaluation and Storage")

sured. The blossom is stored under shelter in layers of about 35 cm thickness which decreases the danger of moulding. One distillery produces between two and ten tons of oil during the season.

Upon completion of the production the oil of all distilleries is transported to the central factory of "Bulgarska Rosa" in the town of Karlovo. The oil of each barrel is evaluated on the basis of the flavour and the data of the classical and the gas chromatographic analysis. This is necessary for the selection of proper lots of oil and their blending to the new brands of the Bulgarian lavender oil—"Hemus," "Karlovo," "Kazanlik" and "Svejen." The first brand bears the Slavonic name of the Balkan mountain while the remaining three are named after the towns in the Rose Valley.

Each brand of oil is blended in lots of 5-20 tons in stainless-steel reservoirs and is allowed to stay there at least for one month. Prior to shipment to the customers the oil is treated again with sodium sulphate and after filtration is transferred into clean zinc-coated iron barrels. Each barrel is ac-

Table V. Production of lavender oil for 1950-1980 according to Staikov and coworkers[4] and "Bulgarska Rosa"

Year	Oil (tons)
1950	0.7
1955	4.3
1960	21.0
1965	60.0
1970	147.0
1972	155.0
1975	120.0
1980	108.0

companied by a certificate of the quality.

Besides these four regular brands, "Bulgarska Rosa" offers also lots of lavender oil, selected or composed according to the customers' samples.

The annual production of lavender oil in Bulgaria for 1950-1980 is given in Table V.

Bulgarian Lavender Oil Types

The improvements of the lavender plantations have increased the production of lavender oil in Bulgaria and considerably improved and stabilized its quality. This was reflected in the precise requirements of the Bulgarian State Standard of 1980 (Table VI) for the recent brands of the Bulgarian lavender oil.

At the same time, the part of the distilled lots with a higher content of esters was increased. The data in Table VII consider oils from the period 1977-1981 distilled in three production regions.

The sharp and unexpected increase in the production during 1970-1972 up to 150 t (see Table V) due mainly to the simultaneous harvesting of the large old fields still occupied by the local population and of the large plantations with the new lavenders which have been created in 1965-1968 and by 1970 reached their technical ripeness. The temporary enthusiasm during the same years in cultivating some clones of high productivity (80-120 kg oil per hectare) but yielding lower grade oils, also contributed to the sharp increase in the production. After 1972 all these "perspective" clones were eradicated. Several old and low productive plantations of the local population were also neglected after 1970 together with some others in the remote areas where the cultivation was unfavourable.

Today the Bulgarian essential oils industry is in possession of plantations and plant material sufficient for the production of approximately 100 t of lavender oil annually. The plant variety and the ecological factors in the local sub-regions afford better possibilities for controlled production of large and well standardized lots of oil as well as of smaller selected lots than the old, restricted in its own biological limits local population. All regular brands of the Bulgarian lavender oil are produced only by blending the natural oils without any further processing and without addition of any aromatic substances of natural or synthetic origin. Their production, as well as that of all Bulgarian natural aromatic products in general, is under the permanent State control.

Beside the distilled lavender oil, the lavender blossoms are used for production of the common concrete and absolute of lavender as well as concrete and absolute of a type named "Lavera." Their discussion is outside of the present review.

Apart from its application in the perfumery, the Bulgarian lavender oil is also an active agent for control of the clothes-moth.[24] It drives away the matured moths and suppresses the growth of their larvae. For this purpose the local people use the lavender flowers or a piece of cloth soaked in lavender oil and placed among the clothes. Suitable preparations containing lavender oil (paraffin bars[24] or oil dispensers) are produced for wide use.

General Evaluation of Lavender Oil

The evaluation of the quality of the lavender oil, being, as many other natural products a complex mixture, creates considerable difficulties to the producers and consumers due to the differences in the chemical composition and the fragrance of the individual lots. These differences are results of the strong biological polymorphism of the lavender, of the wide propagation by means of selected clones or cross-pollinated seeds and of the local environmental influence. Additional complications create the occasional or deliberate admixing with lavadine or spike oils as well as the skillful adulteration with synthetic products or less expensive isolates of other oils.

The subjective olfactive evaluation is of basic importance for the general qualifying of the lavender oil especially if it is combined with objective analytical data. The chemical composition of the lavender and lavandine oils, established by modern methods and instruments (gas chromatography, gas chromatography/mass spectrometry and spectroscopic methods) shows that the difference between them is basically a quantitative one considering either the components forming the "skeleton" (or the "matrix") of the oil and determining the basic line of its fragrance, or the modifying trace components, the contents of which come to about 1% or less.

Gas chromatographic and gas chromatographic/mass spectrometric analysis report about 140 identified components[25,26] common for both lavender and lavandine oils—terpene and nonterpene hydrocarbons, alcohols, aldehydes, ketones, esters, ethers, acids, lactones, phenols. Among them the following individual compounds are considered as decisive for the quality of a typical lavender oil:[27,30] cineol (0.66%), cis- and trans-ocimene (total 11.1%), octanone-3

Table VIII. Chemical composition of some French[27,28] and Italian[29] lavender oils

	French Oils						Italian Oils	
	Population			Maillette		Matherone	L. vera	L. vera selected
	1 (a)	2 (a)	3 (b)	1 (a)	2 (b)	1 (a)	1 (c)	1 (c)
cis- + trans-Ocimene	12.0	13.0	11.2	3.3	2.7	19.0	no data	
Cineol	0.6	0.7	0.7	0.3	0.1	1.5	0.2	0.02
Camphor	<0.3	<0.4	0.3	0.8	0.7	<0.4	0.6	0.3
Linalool	30.0	28.0	31.9	34.5	37.5	34.0	42.2	33.3
Linalyl acetate	34.5	32.5	39.1	44.5	50.2	46.5	41.5	37.8
Terpinene-4-ol-1	3.5	3.5	4.5	0.6	0.7	<1.0	3.6	2.8
Linalool + linalyl acetate	64.5	60.5	71.0	79.0	87.2	74.5	83.7	70.8
Linalyl acetate: linalool	1.15	1.16	1.23	1.29	1.34	1.37	0.99	1.15
Linalool + linalyl acetate / terpinene-4-ol-1	18.4	17.3	15.8	13.7	128.2	74.0	23.2	25.3

(a) Reference 27

(b) Reference 28

(c) Reference 29

Table IX. Chemical composition of the new brands of the Bulgarian lavender oil (average values for 1980-1982, according to "Bulgarska Rosa")

Type	% Esters	Ocimene	Cineol	Linalool	Linalyl Acetate	Terpinene 4-ol-1	I	II	III
Hemus	55.7	7.2	3.0	33.7	37.5	4.5	1.1	15.8	71.2
Kazanlik	43.6	6.8	2.1	30.4	36.8	5.2	1.2	12.9	67.2
Karlovo	42.8	7.7	2.5	30.1	35.2	4.6	1.2	14.2	65.3
Svejen	38.8	7.7	2.6	33.7	37.6	5.8	1.1	12.3	71.3

I. Linalyl acetate:linalool

II. (Linalyl acetate + linalool):terpinene-4-ol-1

III. Linalool + linalyl acetate

Camphor: 0.5% in all types

(1.3%), camphor (0.29%), linalool (32%), linalyl acetate (39%), caryophyllene (5.7%), terpinene-4-ol-1 (4.5%) and lavandulyl acetate (4.2%). Their average values for the oils of a French population[30] are indicated in the brackets. The proportions of some of these components are suggested as specific indicators for some types of lavender oil, for instance, cis-:trans-ocimene, trans-ocimene:octanone-3, (linalool + linalyl acetate):(lavandulol + lavandulyl acetate);[30] these proportions however are subject of some criticism too.[29] The quantitive extremes giving the variation of these main components are established for oils of the French population,[29,30] of the clones Maillette[29,30] and Matherone,[29] of Italian lavenders and lavandines from the Apennines,[31] of French lavandines.[26] Announced also is the application of some of the proportions in the selection of lavandine.[27]

These observations confirm that the quantitative ratio of the main components with the additional participation of the trace components are specific for the chemical composition of lavender oils of a given origin. For illustration, Table VIII states the average amounts[30,31] of cis- and trans-ocimene, cineol, camphor, linalool, linalyl acetate and terpinene-4-ol-1 in French and Italian lavender oils from some populations and clones. Table VIII indicates as well the sum of the linalool and linalyl acetate (A), the proportions of

linalool:linalyl acetate (B), A:terpinene-4-ol-1 and A:cis- + trans-ocimene. These additional data, according to the author, offer further information for the characterization of the oils. Similar approach to the trace components (about or below 1%, as for example camphor and cineol for the lavender oils in Table VIII) however hardly could lead to any important conclusion. Normally, the individual influence of a common trace component on the total fragrance or on its nuance is insignificant.

In a similar way, Table IX indicates the average contents of the main chemical components of the regular brands of Bulgarian lavender oil—"Hemus," "Kazanlik," "Karlovo" and "Svejen."

The data of Table IX correlate well with those of Table VIII considering the lavender oils and show that the contemporary Bulgarian lavender oil is comparable in many respects with the oils of the French population. In both cases, the quantity of linalyl acetate and linalool, their sum and proportion, as well as their proportion with terpinene-4-ol-1 are within one and the same range. Relatively lower is the sum of cis- + trans-ocimene, i.e., at an average of 7.2% as against 12% for the French oils, while the quantity of terpinene-4-ol-1 is higher (5.0% as against 3.8% average values). In both cases the total amount of these main components is very similar, too (83.7% as against 82.2%, average value). The balance to 100% is a complex mixture of a large number of substances presented in the total oil either in traces or in a few percents.

In any way, the final characteristic and assessment of an oil is up to the perfumer's nose.

Bearing in mind both the chemical and odour characteristics, the author shares the opinion that the contemporary Bulgarian lavender oil appears as a new type which is presented to the customers in four regular brands—"Hemus," "Kazanlik," "Karlovo" and "Svejen." It is too early now to state whether within the next 5-10 years, the oil will retain its present level or if its quality will gradually improve as a result of further selection, cultivation and environmental influence.

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