A Preliminary Analysis of Some Lavender and Lavandin Cultivars

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Over the years a number of papers have appeared which have evaluated the oils of clones of lavender (*Lavandula angustifolia* Mill.) and lavandin (*L.* x *intermedia* Emeric ex Loisel.) which were developed by industry or governmental agencies: Algeria,[1] Bulgaria,[2-5] France,[6-8] Hungary,[9,10] Italy,[11-14] New Zealand,[15] and the U.S.S.R.[16,17,19] Many of the clones reported in these papers are proprietary, so we have begun our research on readily available clones. We have examined the essential oils of twelve lavender and five lavandin clones from the nursery trade in the United States and Great Britain to assess them for future agronomic utilization. In order to increase the confidence of extrapolating from a laboratory situation to commercial field conditions, a plant of 'Grosso,' a leading cultivar of lavandin was also included in this study.

We are just beginning to assess the variation within a clone according to harvest. The oils of lavender, lavandin, and spike (*L. latifolia* Med.) have been analyzed from a number of different seasons and countries by investigators,[18-23] and these papers provide some estimate of the variation to be expected.

Materials and Methods

Plants were grown for one to two years on a Sassafras sandy loam topped with 1-2 cm of sand in Camden, Delaware. Approximately 26 g of inflorescences with 50% of the flowers open were harvested at 7:00 A.M., E.S.T. Within two hours, all inflorescences were steam-distilled in a Neo-Clevenger of Moritz after Kaiser and Lang[24] with the modification of Hefendehl.[25] Oils were dried over sodium sulfate, capped with nitrogen, and stored at 3°C until analyzed within 1-10 days.

Oils were chromatographed on a 50 m fused silica WCOT column of 0.25 mm ID coated with Carbowax 20M. A Perkin-Elmer Sigma 1 gas chromatograph with flame ionization detector was used. The injector and detector temperatures were 230°C. The initial column temperature was 65°C for one minute with a rise of 3.0°C/minute to 180°C; this upper limit was held for 35 minutes. The carrier gas, N_2, had a flow rate of 0.5 cc/minute. Percentages were calculated by area normalization.

Identifications were by relative retention, enrichment, and IR. To capture volatiles for IR identification, a 10:1 splitter was installed on the exit port and the oils were chromatographed on a 1.83 m x 0.63 cm OD glass column packed with 15.0% Carbowax 20M on 60/80 mesh NAW Chromosorb W. Peaks were collected on a Beckman-RIIC extrocell GC-1 cooled in dry ice. IR spectra were recorded on a Perkin-Elmer 197 infrared spectrophotometer.

Herbarium vouchers of the plants have been deposited in the Claude E. Phillips Herbarium (DOV), Delaware State College.

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Results

Lavender, white-flowered cultivar. 'Nana Alba' (DOV7496) grows only 2.3 dm high when flowering and is on the edge of hardiness in Plant Hardiness Zone 7. The oil is presented in Table I.

Lavender, pink-flowered cultivars. 'Loddon Pink' (DOV7486), 'Jean Davis' (DOV7489), and 'Rosea' (DOV7497) were examined. All three cultivars have identical floral color, morphology, stature (4.3 dm when flowering), and essential oil patterns (Table I).

Lavender, dark-violet-flowered cultivars. The oils of 'Hidcote' (DOV7568, 3.1 dm when flowering), 'Mitcham Grey' (DOV7495, 3.8 dm when flowering), and 'Munstead' (DOV7488, 3.8 dm when flowering) are presented in Table I.

Lavender, lavender-blue-flowered cultivars. The oils of 'Compacta' (DOV7492, 4.0 dm when flowering), 'Graves' (DOV7490, 3.8-4.8 dm when flowering), 'Irene Doyle' (DOV7569, 3.8 dm when flowering), 'Maillette' (DOV7491, 4.3 dm when flowering), and 'Twickel Purple' (DOV7494, 4.3 dm when flowering) are presented in Table I.

Lavandin, lavender-blue-flowered cultivars. The oils of 'Dutch' (DOV7559, 9.1 dm when

Table I. Essential Oils of Lavender (L. angustifolia)

(Relative Percentage)

Compound	Nana Alba	Loddon Pink	Jean Davis	Rosea	Hid-cote	Mitcham Grey	Mun-stead	Com-pacta	Graves	Irene Doyle	Mail-lette	Twickel Purple
alpha-thujene	-	trace	0.01	0.01	trace	trace	0.01	0.03	trace	trace	0.02	0.02
alpha-pinene	0.12	0.51	0.24	0.43	0.11	0.15	0.31	0.43	0.31	0.05	0.14	0.40
camphene	-	0.02	0.04	0.04	0.04	0.06	trace	0.50	0.02	0.04	0.28	0.26
beta-pinene	0.06	0.05	0.11	0.12	0.18	0.09	0.12	0.25	0.04	0.01	0.07	0.08
sabinene	0.03	0.08	0.12	0.14	0.10	0.10	0.08	0.06	0.04	0.01	0.02	0.10
delta-3-carene	0.03	0.16	0.25	0.31	0.04	0.09	0.07	0.40	0.09	0.03	0.29	0.08
mycrene	0.12	0.40	0.51	0.62	0.35	0.38	0.22	0.37	0.29	0.11	0.19	0.40
limonene	0.20	0.54	0.82	0.97	0.62	0.71	0.52	0.26	0.35	0.05	0.16	0.59
1,8-cineole	0.64	1.40	2.32	2.63	1.68	1.48	4.92	1.20	0.92	0.06	0.03	2.19
cis-beta-ocimene	0.96	0.12	0.15	0.16	4.34	8.10	4.52	6.69	7.09	3.52	0.86	4.30
trans-beta-ocimene + gamma-terpinene	0.23	0.43	0.30	0.46	3.72	3.08	0.23	3.71	0.48	3.53	0.97	0.22
3-octanone	0.80	1.27	1.38	1.66	-	-	2.27	-	-	-	-	0.45
para-cymene	0.04	0.13	0.19	0.17	0.06	0.09	0.17	0.18	0.10	0.05	0.13	0.16
terpinolene	0.03	0.07	0.07	0.07	0.03	0.03	0.05	0.06	0.09	0.03	0.03	0.06
n-hexyl isobutyrate	-	0.03	0.16	0.04	0.03	0.02	0.04	0.04	0.05	0.02	0.06	0.04
trans-allo-ocimene + 1-octen-3-yl-acetate	3.26	0.27	0.40	0.41	0.97	0.70	0.11	0.69	0.42	0.39	0.44	1.73
3-octanol	0.19	0.04	0.02	0.03	0.04	0.02	0.18	0.10	0.12	0.07	0.06	0.01
cis-allo-ocimene	0.02	0.04	0.04	0.06	0.17	0.16	0.06	0.11	0.08	0.06	0.07	0.09
n-butyl butyrate	-	0.11	0.26	0.26	-	-	-	-	-	-	-	-
n-hexyl butyrate	-	-	-	-	0.25	0.17	0.23	0.22	0.15	0.51	0.29	0.27
cis-linalool oxide	0.21	-	-	-	0.07	0.03	0.29	0.05	-	0.13	-	0.11
1-octen-3-ol	0.33	1.42	1.64	1.57	0.03	0.05	0.07	0.13	1.10	0.07	0.26	0.50
trans-linalool oxide	-	0.03	0.03	0.04	-	-	-	0.05	0.04	0.10	0.21	0.09
camphor	0.01	0.06	0.27	0.05	0.10	0.12	0.29	0.21	0.12	0.18	0.31	0.28
linalool	10.06	46.76	46.26	40.95	9.71	6.31	50.52	22.00	33.89	23.96	45.10	26.44
linalyl acetate	35.94	7.46	9.78	10.97	56.60	54.68	9.08	34.99	8.22	40.74	34.89	33.78
terpinen-4-ol	23.23	-	-	-	1.91	1.53	9.66	-	-	-	-	-
terpinen-4-ol + lavandulyl acetate	7.45	25.51	21.51	21.32	3.63	5.68	2.19	3.90	29.28	3.61	0.19	9.02
beta-caryophyllene	4.30	0.11	0.11	0.16	4.29	3.04	0.65	5.41	0.16	6.28	3.14	1.42
n-hexyl tiglate	0.46	0.08	0.10	0.09	0.08	0.09	0.10	0.08	0.12	0.09	0.09	0.09
lavandulol	0.46	6.24	5.52	7.52	0.83	1.04	3.41	0.03	2.32	0.89	0.06	0.84
borneol + alpha-terpineol	0.56	0.45	0.48	0.26	0.58	0.54	0.29	0.69	0.48	0.27	0.57	0.68
neryl acetate	0.36	0.10	0.13	0.09	0.30	0.21	0.09	0.18	0.14	0.13	0.14	0.21
geranyl acetate	0.36	0.18	0.23	0.13	0.40	0.34	0.12	0.36	0.26	0.25	0.37	0.34

(t=less than 0.01%)

Table II. Essential Oils of Lavandin (L. x intermedia)

(Relative Percentage)

Compound	Dutch	Grappen-hall	Hidcote Giant	Prov-ence	Seal	Grosso
alpha-thujene	0.02	0.06	trace	trace	trace	trace
alpha-pinene	1.09	1.11	0.21	0.10	1.14	0.74
camphene	0.35	0.39	0.20	0.16	0.06	0.27
beta-pinene	1.43	1.27	0.24	0.27	1.95	0.79
sabinene	0.64	0.63	0.15	0.13	0.75	0.25
delta-3-carene	0.29	0.34	0.03	0.23	0.34	0.11
myorene	1.21	1.39	0.56	0.21	1.07	0.46
limonene	1.92	2.25	0.82	0.43	1.08	0.68
1,8-cineole	21.16	21.65	6.46	6.43	26.01	8.50
cis-beta-ocimene	4.57	5.29	0.69	0.63	2.21	1.06
trans-beta-ocimene + gamma-terpinene	1.25	1.29	1.96	0.15	0.18	0.48
3-octanone	-	-	-	0.36	0.65	-
para-cymene	0.10	0.11	0.05	0.12	0.09	0.05
terpinolene	0.34	0.35	0.18	0.32	0.09	0.22
n-hexyl isobutyrate	0.06	0.20	0.07	0.17	0.07	0.06
trans-allo-ocimene + 1-octen-3-yl-acetate	0.03	0.02	0.29	0.16	0.02	0.29
3-octanol	0.01	trace	0.06	0.16	0.02	0.04
cis-allo-ocimene	0.05	0.04	0.03	0.15	-	0.08
n-hexyl butyrate	0.33	0.29	0.29	0.68	0.32	0.19
cis-linalool oxide	0.01	-	0.07	0.21	0.01	0.04
1-octen-3-ol	0.44	0.45	0.15	0.84	0.91	0.23
trans-linalool oxide	0.05	-	0.06	-	-	0.08
camphor	8.61	2.69	1.78	3.00	0.39	7.40
linalool	33.69	34.11	35.68	34.47	40.97	24.22
linalyl acetate	3.06	2.77	30.80	3.12	2.23	29.36
terpinen-4-ol	2.43	2.33	0.11	6.59	4.72	3.16
lavandulyl acetate	0.64	0.65	1.88	0.48	0.39	3.76
beta-caryophyllene	0.58	0.48	0.91	0.78	1.76	1.94
n-hexyl tiglate	0.09	0.08	0.18	0.38	0.13	0.08
lavandulol	1.24	1.19	0.70	0.78	1.37	0.79
borneol + alpha-terpineol	1.13	0.96	1.09	1.35	1.53	0.98
neryl acetate	0.06	0.30	0.22	0.69	0.71	0.15
geranyl acetate	0.31	0.26	0.51	0.72	0.38	0.51

(t = less than 0.01%)

flowering), 'Grappenhall' (DOV7562, 10.1 dm when flowering), 'Grosso' (DOV7561, 7.6 dm when flowering), 'Hidcote Giant' (DOV7563, 7.6 dm when flowering), 'Provence' (DOV7567, 8.4 dm when flowering), and 'Seal' (DOV7564, 8.4 dm when flowering) are presented in Table II.

Conclusions

The oil of 'Nana Alba' (Table I), the white-flowered cultivar, is extremely high in terpinen-4-ol. Prager and Miskiewicz[20] reported an average of 6.3% terpinen-4-ol + beta-caryophyllene in commercial lavender oils with a range of 1.0-11.8%; 'Nana Alba' has 23.33% terpinen-4-ol. The lavandulyl acetate (7.45%) and beta-caryophyllene (4.30%) levels are also high, while the linalool (10.06%) level is low. The delicacy of 'Nana Alba' and its marginal hardiness also preclude it from any agronomic utilization.

Of the pink-flowered cultivars (Table I), all are high in terpinen-4-ol + lavandulyl acetate (21.32-25.51%). The content of linalyl acetate is low (7.46-10.97%) compared with commercial lavender oils, which have an average of 33.5% and a range of 27.6-49.0%.[20] Further work is being done to establish the statistical variation of the oils of these cultivars in order to verify that these are all ramets of the same clone. Like 'Nana Alba,' these cultivars are delicate and comparatively low-yielding.

Two of the dark-violet-flowered cultivars (Table I), 'Hidcote' and 'Mitcham Grey,' are low in linalool (9.71% and 6.31%, respectively) but high in linalyl acetate (56.60% and 54.68%, respectively); commercial lavender oils have an average linalool content of 38.5% with a range of 11.7-42.6%.[20] The other dark-violet-flowered cultivar, 'Munstead' (Table I), is low in linalyl acetate (9.08%) but high in linalool (50.52%).

Of the lavender-blue-flowered cultivars (Table I), 'Compacta,' 'Irene Doyle,' 'Maillette,' and 'Twickel Purple' approach the commercial lavender oils.[20] 'Graves,' however, is low in linalyl acetate (8.22%) and high in terpinen-4-ol + lavandulyl acetate (29.28%). 'Irene Doyle' offers the best choice for agronomic development because of its ability to flower again in September (a property shared with the lavandins 'Dutch,' 'Grappenhall,' and 'Provence'). We have begun genetic research to increase the yield per acre at both flowerings of 'Irene Doyle.'

Of the lavandins (Table II), only 'Hidcote Giant' approaches the commercial selections of 'Abrialii,' 'Grosso,' and 'Super.'[20,21] In 'Hidcote Giant' the terpinen-4-ol is low (0.11% in 'Hidcote Giant' versus 0.4-1.8% in 'Abrialii,' 1.5-3.9% in Grosso,' and 0.4-1.0% in 'Super'). The content of camphor in 'Hidcote Giant' is also low (1.78% in 'Hidcote Giant' versus 7.9-9.3% in 'Abrialii,' 6.3-7.6% in 'Grosso,' and 4.9-6.9% in 'Super'). The content of trans-beta-ocimene + gamma-terpinene of 'Hidcote Giant' (1.96%) is higher than 'Grosso' but within the range reported for 'Abrialii' and 'Super.' Further research is being performed on the yield of 'Hidcote Giant.'

The other lavandins (excluding 'Grosso') have a low level of linalyl acetate: 3.06% in 'Dutch,' 2.69% in 'Grappenhall,' 3.12% in 'Provence,' and 2.23% in 'Seal' (compare these with 18.6-33.1% for 'Abrialii,' 31.8-37.2% for 'Grosso,' and 40.0-45.2% for 'Super'). The content of 1,8-cineole is high in 'Dutch' (21.16%), 'Grappenhall' (21.65%), and 'Seal' (26.01%).

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