THE BIODIVERSITY OF *Lavandula angustifolia* MILL. F_1 HYBRIDS

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Abstract. *Lavandula angustifolia* MILL. polycross hybrids have been studied in the third year of vegetation. The biodiversity of the hybrids is supported by value indices of the quantitative characters, content and chemical composition of the essential oil, leaf colour and shape, corolla colour. Thus, different polycross hybrids have a plant height of 41-66 cm, the length of the inflorescence spike of 5.6-13.4 cm, and the length of the inflorescence stem ranges from 10.6 cm to 27.1 cm. The content of hydrodistilled oil varies between 2.010% and 5.900% (dry matter) in different hybrids. 28-31 compounds of the essential oil have been identified. The concentration of the major essential oil components is as follows: linalool - 34.6-67.75% and linalyl acetate -12.5-34.5%. These two major components are followed by terpene-4-ol, the concentration of which is high in most of the hybrids (6.09-14.2%).

Keywords: *Lavandula angustifolia,* hybrid, essential oil, biodiversity, stem ranges.

Rezumat. Biodiversitatea hibrizilor F_1 de *Lavandula angustifolia* MILL. Au fost studiaţi hibrizi policross F_1 de *Lavandula angustifolia* MILL. Biodiversitatea hibrizilor este susţinută de indicii valorilor caracterelor cantitative, conţinutului şi componenţa chimică a uleiului esenţial, culoarea şi forma frunzelor, culoarea corolei florilor. Astfel, genotipurile hibride au talia plantelor de 41-66 cm, lungimea spicului floral de 5,6-13,4 cm, iar lungimea tijei florale variază de la 10,6 cm până la 27,1 cm. Conţinutul de ulei esenţial separat prin hidrodistilare variază la diferiţi hibrizi de la 2,010 până la 5,900%(s.u.). Se deosebesc hibrizii şi prin concentraţia componenţilor majori ai uleiului esenţial: linalool - 34,6-67,75%, acetat de linalilă -12,5-34,5%. În uleiul esenţial al majorităţii hibrizilor linaloolul şi acetatul de linalilă este urmat de un al treilea component major (+) terpen-4-ol, în concentraţie de până la 14,2%, la formele parentale acesta fiind un component minor.

Cuvinte cheie: *Lavandula angustifolia*, hibrid, ulei esenţial, biodiversitate, tijă florală.

INTRODUCTION

Lavandula angustifolia MILL. – Lavender in the family Lamiaceae, was known as a medicinal and aromatic plant in the countries bordering the Mediterranean basin as early as 600 years before Christ. The name of *Lavandula* comes from the Latin *lavare* – to wash because the Romans used this species to scent baths. It was also used for preparation of aromatized fatty oils. The essential oil extracted by steam distillation is the main product of the fresh blossoms of this species and is used in the perfumery industry, the manufacture of cosmetics and various health and hygiene products. It is also employed in the preparation of different creams, pharmaceutical products that have a calming, antidepressant, and antibacterial effect. Lavender is a valuable meliferous plant because its nectar is rich in carbohydrates. The species is also known and used as an ornamental plant. Excellent appearance of evergreen plants, the inflorescences with different shades of blue flowers, very long flowering period - 35-40 days, the aroma of flowers are successfully exploited (GONCEARIUC, 2008). In the Republic of Moldova, lavender is grown on relatively large areas and the essential oil is designed for export.

MATERIAL AND METODS

Lavender polycross hybrids in the third year of vegetation were used as biological material. The following morphological characters that determine the productivity and hybrid biodiversity: plant height, the length of inflorescences, inflorescence spikes and inflorescence stems, the number of whorl per inflorescence, the number of inflorescences per plant were assessed in the experiments. Essential oil was derived from fresh inflorescences at the flowering stage through hydrodistillation in the Ginsberg apparatus, while the oil content was recalculated for dry matter. After distillation, the essential oil was dried over anhydrous sodium sulphate. The chemical composition of the essential oil and the concentration of the components were estimated using a gas chromatographic analysis coupled with mass spectrometry (GC-MS). The conditions of the gas chromatographic analysis were as follows: Gas Chromatographer Agilent Technologies type 7890 A GC system, type 5975 C Mass Selective Detector US 92014110; Column HP 5 MS 30 m x 0.25 mm x 0.25 µm (5% Phetylmethylsiloxane); injector temperature 2,500^{o}C, detector temperature 2,800^{o}C; the temperature regime of 250^{o}C (10 degrees/min) up to 280 degrees (const. 5.5 min); mobile phase – helium 1 ml/min.

RESULTS AND DISCUSSIONS

A number of *Lavandula angustifolia* MILL. polycross hybrids have been developed and studied. Varieties originating from France, Ukraine and Moldova and the hybrids of these species were included in the hybridization as parental forms. In this paper, we present 10 of the most important producing F_1 hybrids that are prospective for the development of lavender varieties-clones. The biodiversity of the selected hybrids is supported by the indices of different morphological characters. Thus, the plant height varies from 43 to 61 cm, and the inflorescence length from 19.3 cm in the

F1 hybrid Cr26S-85 to 24.5 cm in the hybrid VM-21V (Table 1). It is important for *Lavandula angustifolia* to have the number of verticiles per floral as high as possible and, accordingly, as many flowers per floral spike as possible, because it is known that the highest quantity of essential oil accumulates in the oleiferous glands of flower sepals. The inflorescences of five hybrids (VM-21V, VM-32V, VM-69V, Cr26S-57, Cr26S-58-85, Cr26S) have a relatively high number (6.0-6.8) of whorls. Lavender varieties suitable for mechanized harvesting should have a long inflorescence stem. The majority of the polycross hybrids meet these requirements and the longest flower stems were attested in the hybrids Cr26S-21, Cr26S-173, VM-21V, VM-32V. The hybrids assessed show promise due to the fact that each plant has a large number of floral stems. The essential oil content varies in different hybrids from 2.010% to 5.900% (dry matter) and is higher than that of the lavender varieties studied by other authors (HASSIOTIS et al., 2010). Three of the hybrids (VM-32V, VM-69V, Cr26S-57) are distinguished by the highest content of essential oil – 4.491-5.900% (Table 1).

Table 1. The values of productivity indices in *Lavandula angustifolia* MILL. F1 hybrids, 2010.
Tabel 1. Valorile unor indici ai productivității la hibrizii F_1 de *Lavandula angustifolia* MILL., 2010.

Hybrid F_1	**Plant height -cm-**	**Inflorescence length -cm-**	**Length of flower stem -cm-**	**Length of floral ear, -cm-**	**Number whorls/ inflorescence**	**Number of inflorescences / plant**	**Content of essential oil, % (dry matter)**
		X± sX	X± sX	X± sX	X± sX		
VM-18V	58.0	22.8± 3.48	15.4±2.09	7.4±0.67	5.7±0.79	**425**	3.961
VM-21V	60.8	24.5±2.85	**16.4**±1.93	8.1±0.89	**6.0**±0.45	325	3.962
VM-32V	55.5	21.9±2.65	**16.0**±3.24	5.9±0.51	**6.2**±0.45	324	**4.491**
VM-56V	54.0	21.4±2.16	14.6±1.52	6.8±0.90	5.8±0.51	301	3.865
VM-69V	61.0	25.0±1.81	15.8±1.45	9.2±1.43	**6.2**±0.45	297	**4.491**
Cr26S-21	60.0	20.8±1.3	**17.4**±2,8	3.4±0.2	5.0±1.1	360	3.440
Cr26S-57	45.0	19.4±3.8	13.2±4.1	5.6±1.8	**6.6**±0.7	280	**5.900**
Cr26S-58	52.0	19.9±2.1	14.0±0.9	5.9±1.2	**6.1**±0.6	**416**	2.840
Cr26S-85	43.0	19.3±2.1	13.4±0.8	5.9±1.3	**6.8**±0.8	320	3.570
Cr26S-173	53.0	21.2±3.6	**16.8**±2.4	4.4±1.2	4.9±0.6	**417**	2.700

The lavender polycross hybrids are also distinguished by the flower corolla colour that varies from light blue (Fig. 1b) to different shades of violet (Figs. 1a, c, d). The biodiversity of the lavender polycross hybrids is also supported by the bush shape, which is pyramidal, round or semicircular.

a b c d

Figure 1. The biodiversity of *Lavandula angustifolia* F_1 hybrids (original). / Figura 1. Biodiversitatea hibrizilor F_1 de *Lavandula angustifolia.*

The biodiversity of the F_1 hybrids is supported not only by the morphological (quantitative) characters but by the concentration of the chemical components of essential oil. Some hybrids also differ by the number of the chemical constituents identified in the essential oil. The chemical composition of the essential oil isolated from fresh flowers by hydrodistillation is characterized by the presence of two major components - linalool and linalyl acetate (Figs. 2 to 5, Table 2). The quality of the lavender essential oil intended for perfumery is known to depend on the concentration of linalyl acetate. The higher the concentration of this component, the higher the quality of the essential oil is. The antimicrobial action depends on the concentration of linalool in the essential oil (GONCEARIUC, 2004, 2008). The new polycross hybrids differ between them by the concentration of the major components, as well (Figs. 2 to 5, Table 2). Thus, the concentration of linalyl acetate ranges from 12.55% in the essential oil separated from the inflorescences of the hybrid Cr.26S-21 (Fig. 5, Table 2) to 34.28% of the essential oil of the hybrid Cr.26S-85 (Fig. 4, Table 2). It should be noted that the hybrids developed differently from the lavender varieties described by other researchers (YUANYUAN et al., 2008; HASSIOTIS et al., 2010a, HASSIOTIS et al., 2010b) due to a higher concentration of linalyl acetate in the essential oil.

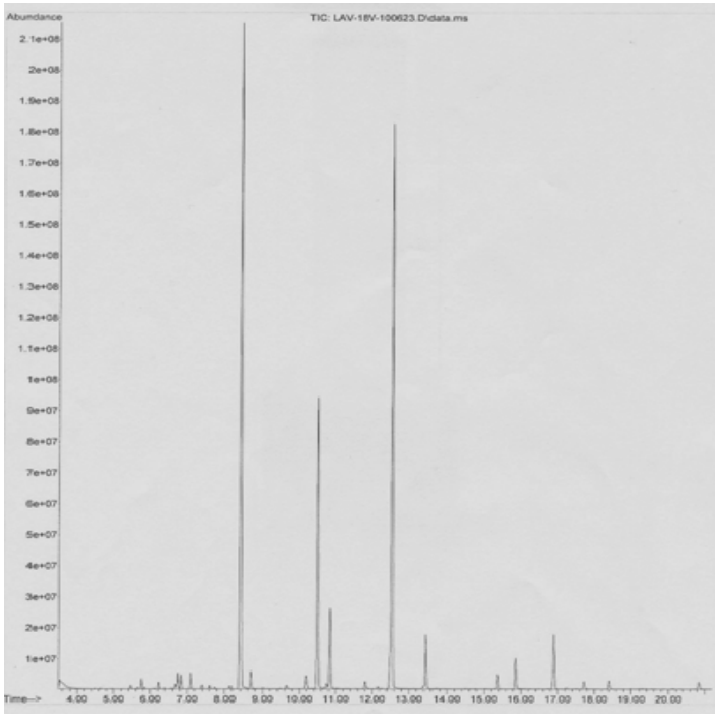

Figure 2. Gas-chromatogram of essential oil of the lavender hybrid VM-18V. / Figura 2. Gaz cromatograma uleiului esențial a hibridului VM-18V de lavandă.

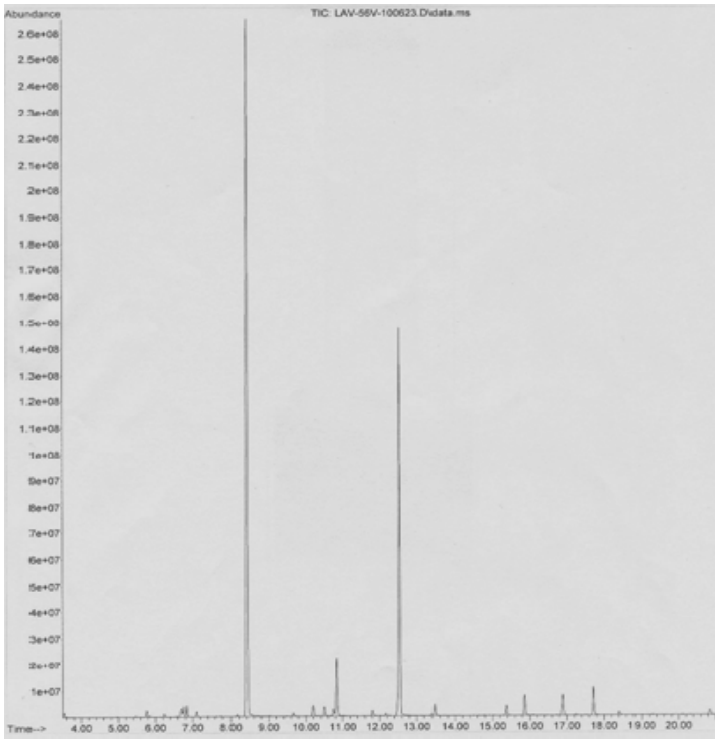

Figure 3. Gas-chromatogram of essential oil of the lavender hybrid VM-56V. / Figura 3. Gaz cromatograma uleiului esențial a hibridului VM-56V de lavandă.

The lavender polycross hybrids differ by the concentrations of linalool, which vary from 33.64% in the essential oil yielded from the inflorescences of the Cr.26S-85 hybrid (Fig. 4) to 64.83% in the essential oil of the VM-32V hybrid (Table 2). Some hybrids (VM-18V) are distinguished by higher concentrations reaching up to 14.19% of (+) terpinen-4-ol (Fig. 2, Table 2), as opposed to other hybrids in which the concentration of this component ranges from 6.9% in the hybrid VM-21V to 9.01% in the hybrid Cr.26S-57 (Table 2), or makes only 0.59% in the essential oil of the VM-56V hybrid.

Some differences were also observed in the presence and concentration of minor components in the essential oil of the polycross hybrids. For example, β-pinene was identified in the essential oil of only three hybrids, and α-pinene is absent in the oil of the hybrid VM-56V only.

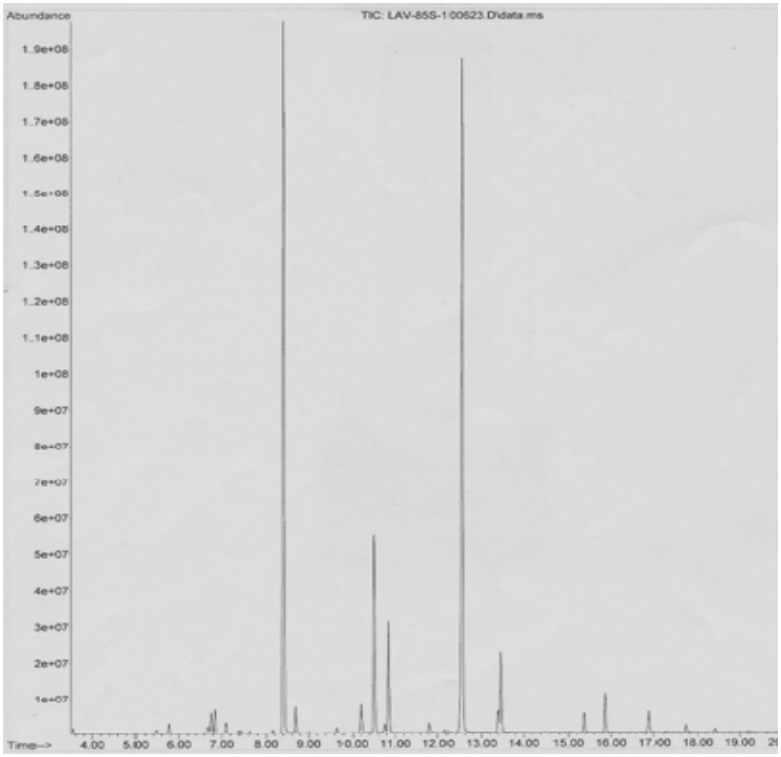

Figure 4. Gas-chromatogram of essential oil of the lavender hybrid Cr.26S-85. / Figura 4. Gaz-cromatograma uleiului esențial a hibridului de lavandă Cr.26S-85.

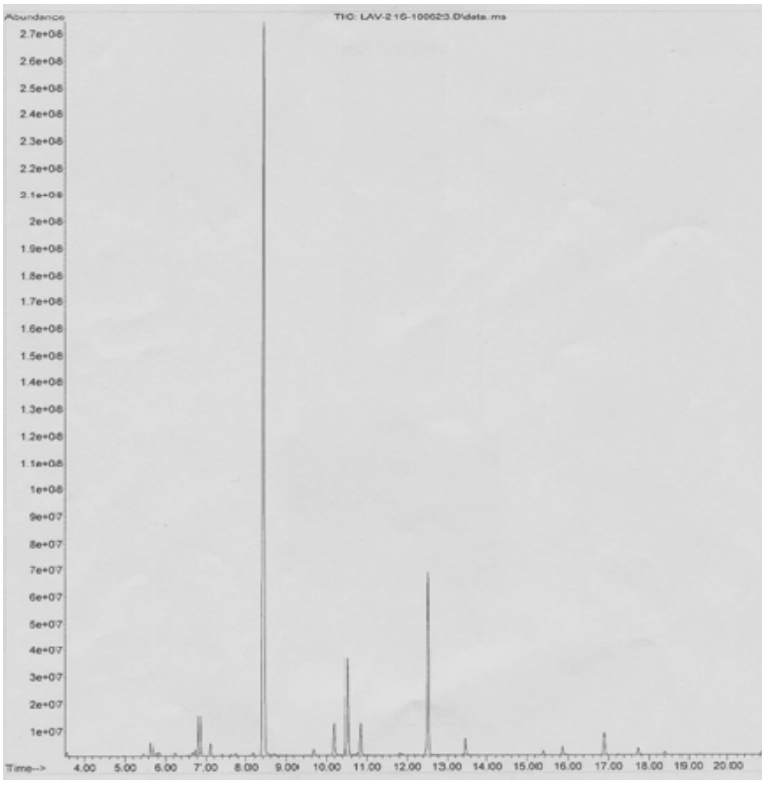

Figure 5. Gas-chromatogram of essential oil of the lavender hybrid Cr.26S-21. / Figura 5. Gaz-cromatograma uleiului esențial a hibridului de lavandă Cr.26S-21.

Table 2. Chemical composition (%) of the essential oils of the ten best *Lavandula angustifolia* F_1 hybrids.
Tabel 2. Compoziţia chimică (%) a zece din cei mai buni hibrizi F_1 de *Lavandula angustifolia.*

No.	Components	Area (%)									
		VM-18V	VM-21V	VM-32V	VM-56V	VM-69V	Cr.26S-21	Cr.26S-57	Cr.26S-58	Cr.26S-85	Cr.26S-173
1	α-pinene	0.036	0.030	0.020	-	0.02	0.02	0.04	0.04	0.03	0.03
2	camphene	0.022	0.03	0.03	0.04	0.03	0.03	0.03	0.06	0.06	0.03
3	1-octen-3-ol	0.170	0.13	0.11	0.08	0.23	0.14	0.30	0.13	0.17	0.08
4	β-pinene	-	0.02	-	-	-	0.02	-	0.02	-	-
5	3-octenonă	0.07	0.07	-	0.02	0.10	0.72	0.19	0.04	0.04	0.02
6	β-myrcene	0.42	0.38	0.25	0.34	0.22	0.21	0.24	0.48	0.38	0.41
7	4-metil-octanol	0.07	0.07	-	0.08	0.12	0.23	0.07	0.04	0.02	-
8	α-felandren	0.03	0.03	0.02	0.02	0.02	0.03	0.04	0.04	0.03	0.03
9	acetic acid hexyl ester	0.30	0.11	0.08	0.20	0.16	0.22	0.13	0.09	0.03	0.06
10	limonene	0.25	0.66	0.07	0.65	0.29	0.30	0.32	0.66	0.36	0.43
11	1,8-cineol	0.75	0.93	1.23	0.61	0.92	0.39	0.53	0.88	0.87	0.26
12	β-trans-cymene	0.61	0.34	0.34	0.63	0.30	2.31	2.93	1.60	0.94	2.44
13	β-cis-ocymene	0.72	0.26	0.16	0.30	0.27	0.71	1.06	1.06	0.46	0.59
14	Δ^3-caren	0.17	0.17	0.12	0.15	0.17	0.25	0.17	0.23	0.17	0.18
15	(-)linalool	34.60	47.77	**64.83**	55.40	**61.07**	**63.58**	**59.52**	39.48	**33.64**	36.58
16	octenol-3acetat	0.85	0.16	0.10	0.11	0.15	0.20	0.21	0.56	1.13	0.40
17	(+)camphor	0.20	0.29	0.23	0.24	0.34	0.46	0.21	0.28	0.29	0.16
18	borneol	0.87	1.32	1.21	0.82	1.02	2.62	1.27	1.30	1.58	0.80
19	(+)terpinen-4-ol	**14.19**	6.09	7.39	0.59	7.72	6.34	9.01	7.22	8.83	7.24
20	α-terpineol	3.92	3.50	2.77	3.96	2.88	2.44	2.19	4.87	5.06	4.54
21	cis-geraniol (nerol)	0.40	0.35	0.20	0.39	0.20	0.14	0.15	0.54	0.53	0.51
22	iso-borneol	0.02	0.02	0.02	0.02	0.06	0.09	0.06	0.18	0.15	0.15
23	linalyl acetate	**30.05**	28.69	**15.05**	26.83	17.75	**12.55**	15.14	**30.76**	**34.28**	**34.05**
24	lavandulol acetate	2.80	1.23	0.91	0.90	0.38	1.22	0.69	1.19	3.68	2.10
25	nerol acetate	0.74	0.65	0.37	0.65	0.37	0.31	0.28	0.92	0.89	0.94
26	geranyl acetate	1.48	1.35	0.76	1.32	0.79	0.64	0.54	1.83	1.72	1.83
27	β-cariophilen	2.98	2.49	1.41	1.59	2.00	1.76	1.21	1.21	1.13	1.65
28	α-ergamotene	0.09	0.13	0.06	0.08	0.10	0.06	0.07	0.06	0.06	0.10
29	α-farnesene	0.47	0.15	0.57	1.77	0.10	0.48	1.51	1.34	0.37	1.83
30	Z-β-farnesene (germacren)	0.48	0.28	0.15	0.27	0.33	0.25	0.50	0.51	0.21	0.83
31	Caryophyllene oxide	0.48	0.45	0.39	0.47	0.35	0.30	0.17	0.27	0.25	1.31
	Total %	98.24	98.03	98.75	98.53	98.46	98.74	98.26	97.89	97.36	99.58

CONCLUSIONS

Lavandula angustifolia MILL polycross F_1 hybrids have been developed and evaluated. The biodiversity of the hybrids is supported by the quantitative characters which influence the productivity - plant height (41-66 cm), length of inflorescence spike (5.6-13.4 cm), the number of whorl per inflorescence (4.9-6.8), the number of inflorescences per plant (280-425), the colour of the flower corolla. The essential oil content varies in different hybrids from 2.010 to 5.900% (dry matter). The biodiversity of the hybrids is enhanced by different concentrations of essential oil components. The linalool concentration in the essential oil varies from 34.6 to 67.75% and linalyl acetate - from 12.5 to 34.5%.

In the essential oil of most hybrids, linalool and linalyl acetate is followed by the third major component - terpinen-4-olat at a concentration of up to 14.19%.

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