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Effect of Watering of Selected Seasoning Herbs with Water Treated with Low-Temperature, Low-Pressure Glow Plasma of Low Frequency

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Abstract: Plantations of lovage, marjoram, rosemary and thyme were watered with water treated with low-temperature, low-pressure glow plasma of low frequency. Such watering appeared beneficial to the extent dependent on particular herb. In terms of crop yield and quality, water treated with glow plasma performed best in the case of rosemary, and the worst results were observed for thyme. When yield of essential oils are taken into account, only in the case of lovage did such watering appear beneficial, while in the remaining cases it had no effect. However, such watering considerably changed the composition of essential oils. These changes were specific for a given herb and involved the quantity of particular components of the oils. Only in the essential oil from lovage did γ-terpinene appear as its novel component.

Keywords: essential oil; lovage; marjoram; rosemary; thyme

1. Introduction

Following the invention of low-temperature, low-pressure glow plasma of low frequency (LPGP) and the constructing of generators for such plasma [1,2], a series of papers was published describing the macrostructure and the resulting physical, physicochemical and chemical properties of water treated with LPGP. It appeared that these properties depended, among other things, on whether that treatment was performed in the air, under nitrogen, ammonia, carbon dioxide, methane or molecular oxygen [3–8]. Subsequent papers demonstrated that these diverse properties resulted in specific functional properties for different kinds of water. The distinct functional properties of various kinds of LPGP-treated water have been presented for lettuce and grass [9], peppermint [10], cress [11], lavender [12], basil [13] and oregano [14]. The crop quality and yield of those plants, and in case of herbs, also the yield and composition of their essential oils, changed considerably. The selection of a given kind of water for watering those herbs could be interesting for herbal medicine and aromatherapy.

Among the different kinds of LPGP-treated water production, that in the air (LPGPA) was the simplest, and hence the most economically profitable. Therefore, in this paper, the functional properties of LPGPA are investigated in the case of selected seasoning herbs. The novelty of this paper lies in improving the yield and quality of the crops of the investigated herbs by watering them with water treated with this particular glow plasma in the air. This treatment also resulted in a modified composition of the essential oils, which could be of interest for applications in herbal medicine and aromatherapy. Thus, the treated water was used to water plantations of lovage, marjoram, rosemary

and thyme, and these results are presented in terms of the crops' quality and yield, as well as the effect upon the yield and composition of the essential oils extracted from those cultivars.

Lovage, a species from the genus *Levisticum* in the family Apiacea [15], is a common seasoning herb and a vegetable. Its leaves, roots and seeds are used [16]. Its roots, which contain, among other things, furanocoumarins [17], are also used as a mild aquaretic [18].

Marjoram (*Origanum majorana*), in the form of either green or dry leaves, is used for seasoning soups, stews, dressings, sauces, and as a herbal tea [19].

Rosemary is a member of the mint family Lamiaceae. Apart from seasoning purposes [20], it is also used as a decorative garden plant [21]. Rosemary extract improves the shelf life and heat stability of omega 3-rich oils [22]. Apart from volatile components that can be extracted into essential oil, rosemary contains several phytochemicals, such as rosmarinic, caffeic, ursolic, betulinic, and carnosic acids [21].

Thyme is a member of the genus *Thymus* in the mint family Laminacea. For culinary purposes, *Thymus vulgaris* is commonly used [23,24]. Apart from its seasoning value it is also appreciated for its antimicrobial activity [25–28].

2. Materials and Methods

2.1. Materials

2.1.1. Herbs

Seedlings of all four herbs were purchased from Flower Farm, Tropiszow, 131, 32-125 Wawrzeńczyce, Poland.

2.1.2. Water

Tap water from Bolesławiec of total hardness 129 mg/L $CaCO_3$; pH 7.1; conductivity 334 µS/cm; Fe < 50 µg/L; Mn < 5 µg/L; dissolved oxygen 6.93 mg/L was used.

2.2. Methods

2.2.1. Treatment of Water with Low-Temperature, Low-Pressure Glow Plasma of Low Frequency

Tap water (200 mL) in 250 mL polyethylene bottles was placed in the chamber of the reactor [1] and exposed to plasma for 30 min. Plasma of 38 °C was generated at 5×10^{-3} mbar, 600 V, 50 mA and 280 GHz frequency. The produced water was stored at ambient temperature in 100 mL closed Teflon containers.

2.2.2. Substrate

Substrate was composed of medium size turf fraction Florabalt® Pot Medium-Coarse (Floragard, Oldenburg, Federal Republic of Germany). The medium of pH 5.6, contained 1.2 g/L total salts including 210 mg N/L, 120 mg P_2O_5/L, 260 mg K_2O/L. It was supplemented with multicomponent PG-Mix 18-10-20 fertilizer (1.20 kg/m^3) (Yara, Oslo, Norway).

2.2.3. Trays

QP 15RW multiplates QP 15RW trays (Herkuplast Kubern GmbH, Ering/Inn, Federal Republic of Germany) were used. Each multiplate consisted of 3 × 5 trays. Each tray had a capacity of 280 cm^3. A 1 m^2 area of greenhouse hosted 880 plants.

2.2.4. Herb Plantation

The monofactorial experiment was carried out from 24 February (sowing) until 18 May (harvesting) 2019 in a greenhouse at the University of Agriculture in Cracow. The temperature in the greenhouse was set for 22 and 18 °C during the day and night, respectively. The day time lasted 16 h after sunup.

The passing from the day regime into the night regime was controlled by computer. Automatic additional illumination with sodium lamps was used for 16 h when the natural light intensity fell to below 100 W/m^2. The experiment involved three sets of trays with 24 pots each. Ten seeds of basil were sown into every pot. In one series of experiments, two multiplates hosted 300 plants. To eliminate the parietal effect, 60 plants on the edge of trays were left apart, and therefore, only 240 plants were harvested. Since the experiments were run in triplicate, a maximum of 720 plants were collected for a given series.

The watering was adjusted according to tensiometer readings (Irrometer model SR 150 mm) when soil water tension was <−40 kPa. The plants were watered by hand to avoid the accidental contact of water with leaves. Initially, the plants consumed a total of 3 L water, that is, 1 L for each replicate in the 5-day period until 24 March. In the subsequent 1-month period, the watering was intensified, and the same amount of water was administered to the plants in 3-day periods. In the final period of breading, the plants were watered daily, consuming the same amount of water. In this manner, the watering consumed a total of 40 mL each kind of water daily. The experiment was terminated on 18 May, when the plants were collected. The plants were then dried at 105 °C for 4 h to determine the dry mass of the crops.

2.2.5. Ash

In a vessel weighed with 0.0002 g precision, a substance was weighed with the same precision and the whole was inserted for 10 min into the front of an oven heated to 815 °C. Subsequently, the vessel with the sample was shifted (2 cm/min) into the central region of the chamber. After returning the temperature of the oven to 815 °C, the analyzed sample was maintained inside the chamber for a further 25 min. After that time, the sample was left in the open for cooling to room temperature, and then weighed with a 0.0002 g precision.

2.2.6. Humidity and Final Mass of Plants

Humidity and final mass of plants were determined with a RADWAG MA 50. R balance-dryer (Radom, Poland) with a precision of 0.01 mg.

2.2.7. Condition of Plants

Photographs were taken after 6 weeks of breeding using a NIKON COOLPIX P1000 apparatus.

2.2.8. Separation of Essential Oils for Determination of Their Yield

Samples of the plant (100 g) were steam distilled in a Deryng apparatus with a closed water circulation. The collected oils were transferred to a closed vials.

2.2.9. Gas Chromatographic Analyses

Sample (5 µL) was transferred to closed chromatographic viol and evaporated on a heating plate. Using gas-tight syringe gaseous sample (10 µL) was analyzed using a Bruker 436-GC gas chromatograph coupled with Bruker SCION SQ (single quadruple, electron ionization) mass spectrometer (Durham, UK). The estimations were duplicated.

The instrument was equipped with BR-5 ms; 0.25 nm × 30 m, df = 0.25 µm. The column operated at the following temperature schedule: 50 °C (2 min) at the temperature rate increase 10 °C/min up to 170 °C (0 min), then at 25 °C to 280 °C (5 min). The dispenser, transfer line and source temperatures were 300, 280 and 200 °C, respectively. Sample separation was set for 1:20, helium was used as the carrier gas. The flow of the mobile phase was 1.0 mL/min, and ionization energy was 70 keV. Scanning was performed in the 50–500 m/z range.

Chromatographic signals were identified by comparison with mass spectra available in the National Institute of Standards and Technology (NIST) 11 library. Area under particular chromatographic peaks were calculated involving computer program installed in the chromatograph.

2.3. Statistics

The results were subjected to statistical interpretation, mean values and standard errors were calculated, and the significance of the variables was determined. Statistically significant differences between means ($p < 0.05$) were evaluated using one-way analysis of variance (ANOVA) with a post hoc multiply Duncan's range test [29]. Moreover, the Pearson product-moment correlation coefficients between analyzed variables were calculated. The significance level for correlation coefficient was $p = 0.05$, and the number of pairs for the calculations was N = 216. All statistical analyses were calculated using Statistica 13.3 software (Tibco Software Inc., Palo Alto, CA, USA).

3. Results and Discussion

Figure 1 shows that watering four investigated herbs with LGPGA promoted their growth.

Figure 1. *Cont.*

Figure 1. Pot plantation of four herbs (from the top: lovage, marjoram, rosemary and thyme)**.** In these photographs, pots watered with non-treated water and watered with LPGPA are situated on the left and right, respectively).

Evidently, watering with LPGP promoted the growth of those herbs. The data in Table 1 provide quantitative treatment of those observations.

Humidity collected by the growing plants appeared to be practically independent of the kind of water used. LPGPA is known [3] to be a vector transporting species dissolved in it to the tissues. Therefore, ash content in investigated samples increased as a result of an uptake of minerals from the substrate. That uptake was the lowest in case of thyme (Table 1). It was higher by about 7% than that in cases where the herb was watered with non-treated (control) water. The uptake of minerals by lovage and marjoram watered by LPGPA was almost twice as high.

Watering with LPGPA increased the number of plants by about 50% in rosemary, and only by ~15% in thyme. It was paralleled with the height of plants per one tray. It reached increases of about 40% and only about 25%, respectively. Similarly, the total mass of plants increased by about 21% and 5.5% in rosemary and thyme, respectively. Watering with LPGPA promoted an increase in the number of leaves per plant. This was specific for a given herb, with the highest, ~23%, being in thyme and the lowest, ~10%, being in marjoram. Watering with LPGP resulted in a 100% and only a 10% increase in the mass of stems in thyme and lovage, respectively. The total mass of foliage was promoted by watering with LPGPA only in the case of lovage and thyme. It increased by ~14 and ~5%, respectively. This kind of watering had no influence on that parameter for marjoram, and in the case of rosemary, that parameter decreased by ~3%.

Watering with LPGPA had a considerable influence on the composition of essential oils isolated from the herbs (Table 2). Watering with LPGPA increased the yield of that oil solely in the case of lovage.

In every investigated herb, watering with LPGPA offered the possibility of manipulating the composition of their essential oils, and hence, their functional properties.

Table 1. Characteristics of the planted herbs.

Estimation	Herb/Water [a]							
	Lovage Control	**Lovage LPGPA**	**Marjoram Control**	**Marjoram LPGPA**	**Rosemary Control**	**Rosemary LPGPA**	**Thyme Control**	**Thyme LPGPA**
Number of plants	14 ± 0.5	19 ± 1.0	25 ± 1.0	34 ± 0.5	18 ± 1.0	27 ± 1.0	39 ± 0.5	45 ± 0.5
Height of plants/1 pot [cm]	28.4 ± 2.1	36.4 ± 1.1	12.6 ± 1.7	17.6 ± 1.4	16.3 ± 1.2	26.3 ± 1.3	7.1 ± 0.3	8.7 ± 0.4
Total mass of plant [g]	126.1 ± 1.3	138.1 ± 1.5	65.1 ± 0. 5	71.1 ± 0.3	61.1 ± 0.3	74.1 ± 0.2	110.3 ± 1.5	116.2 ± 0.7
Total number of leaves	42 ± 2	47 ± 2	92 ± 2	103 ± 2	137 ± 2	143 ± 3	224 ± 1	233 ± 2
Number of leaves per plant	16 ± 3	19 ± 3	17 ± 3	19 ± 2	11 ± 2	13 ± 3	13 ± 2	16 ± 2
Mass of stems [g]	77.83 ± 0.14	84.73 ± 0.13	31.05 ± 0.16	36.76 ± 0.12	32.76 ± 0.12	36.26 ± 0.12	2.16 ± 0.12	4.29 ± 0.12
Total mass of foliage [g]	43.98 ± 0.23	50.51 ± 0.22	35.02 ± 0.28	35.13 ± 0.28	30.25 ± 0.32	29.18 ± 0.19	108.32 ± 0.12	112.93 ± 0.62
Mass of one leaf	0.334 ± 0.018	0.338 ± 0.017	0.121 ± 0.012	0.127 ± 0.012	0.094 ± 0.011	0.097 ± 0.009	0.213 ± 0.020	0.214 ± 0.011
Humidity [%]	11.29 ± 0.21	11.32 ± 0.23	9.15 ± 0.18	9.25 ± 0.17	8.23 ± 0.09	8.35 ± 0.04	6.35 ± 0.12	6.48 ± 0.11
Ash [%/per 1 g dry residue]	1.32 ± 0.08	1.49 ± 0.07	1.65 ± 0.03	1.87 ± 0.02	1.23 ± 0.03	1.35 ± 0.04	1.68 ± 0.04	1.82 ± 0.06

[a] Non-treated water was taken as control. LPGPA denotes water treated in the air.

Table 2. Yield and composition of essential oils extracted from herbs watered with nontreated water (control) and LPGPA.

Peak Position in Chromatogram	Retention Time [min]	Component	Herb/Water							
			Lovage		**Marjoram**		**Rosemary**		**Thyme**	
			Control	**LPGPA**	**Control**	**LPGPA**	**Control**	**LPGPA**	**Control**	**LPGPA**
1	7.08	β-Thujene	-	-	0.49	0.27	-	-	0.21	0.08
2	7.27	α-Pinene	0.11	0.03	0.16	0.09	2.85	4.86	0.12	0.06
3	7.68	Camphene	-	-	0.02	-	1.,73	0.72	0.03	0.02
4	7.77	Dihydrosabinene	-	-	-	-	0.05	-	-	-
5	8.22	Sabinene	0.51	0.27	8.25	10.18	0.12	-	0.17	0.19
6	8.36	1-Octen-3-ol	-	-	-	-	-	-	1.23	1.00
7	8.38	(-)-β-Pinene	0.12	0.11	0.35	0.21	2.50	2.49	-	-
8	8.49	3-Octanone	-	-	-	-	-	-	0.07	0.06
9	8.60	β-Pinene	0.11	2.44	2.09	2.00	1.25	1.15	1.33	1.54
11	9.02	ψ-Limonene	0.06	0.06	-	-	-	-	-	-
12	9.05	α-Phellandrene		0.65	0.35	0.30	0.76	0.42	0.20	0.25
13	9,13	3-Carene	-	-	-	-	2.48	2.31	-	-

Table 2. *Cont.*

Peak Position in Chromatogram	Retention Time [min]	Component	Herb/Water							
			Lovage		Marjoram		Rosemary		Thyme	
			Control	LPGPA	Control	LPGPA	Control	LPGPA	Control	LPGPA
14	9.32	α-Terpinene		0.05	1.67	1.56	0.27	0.23	1.92	2.34
16	9.51	o-Cymene	0.17	0.14	0.05	0.06	0.28	0.79	6.84	6.39
17	9,63	D-Limonene	2.82	2.45	1.60	1.49	4.74	5.64	0.25	0.29
18	9.70	β-Phellandrene	20.03	17.64	2.30	2.15	-	-	-	-
19	9.71	Eucalyptol	-	-	-	-	12.41	9.39	0.62	0.58
20	9.77	trans-β-Ocimene	0.44	1.16	0.08	0.08	-	-	-	-
21	10.04	β-Ocimene	0.01	0.04	0.46	0.44	-	-	-	-
22	10.37	γ-Terpinene		3.52	2.13	2.00	0.35	0.37	16.17	18.76
23	10.67	cis-β-Terpineol	-	-	3.90	3.79	0.96	0.90	1.86	1.77
25	11.09	Terpinolene	0.38	0.31	0.56	0.54	2.29	1.76	-	-
26	11.32	3-Hexen-1-ol, propanoate, (Z)-	-	-	-	-	-	-	0.09	0.07
27	11.40	Linalool	-	-	-	-	2.63	2.44	2.67	2.37
28	11.46	cis-4-Thujanol	-	-	38.16	37.36	0.86	0.97	-	-
29	11.98	Chrysanthenone	-	-	-	-	0.30	0.17	-	-
30	12.11	Neo-allo-ocimene	0.07	0.58	0.14	0.13	0.15	0.13	-	-
31	12.24	Artemiseole	-	-	-	-	0.09	-	-	-
32	12.50	trans-(-)-Pinocarveol	-	-	0.04	0.04	-	-	-	-
33	12.51	cis-Verbenol	-	-	-	-	0.91	1.08	-	-
34	12.63	Camphor	-	-	-	-	16.46	12.20	-	-
35	12.89	6-Butyl-1,4-cycloheptadiene	0.01	0.33	-	-	-	-	-	-
37	13.02	Pinocarvone	-	-	0.02	-	0.34	0.32	-	-
38	13.14	Camphenol	-	-	-	-	0.21	0.28	-	-
39	13.19	1,3-Dimethyl-1-cyclohexene	-	-	-	-	0.21	0.21	-	-
40	13.24	endo-Borneol-Dup1	-	-	0.07	0.07	7.92	10.04	0.11	0.08
41	13.35	Isocamphopinone	-	-	-	-	3.11	2.26	-	-
42	13.37	o-Mentha-1(7),8-dien-3-ol	0.47	0.36	-	-	-	-	-	-
44	13.45	Terpinen-4-ol	-	-	0.72	1.02	0.32	0.62	0.13	0.12
46	13.80	α-Terpineol	0.13	0.13	3.11	3.18	1.05	2.63	0.10	0.10
47	13.84	Myrtenol	-	-	-	-	0.29	0.36	-	-
48	13.87	Dihydrocarvone	-	-	0.14	-	-	-	-	-
49	13.99	endo-Borneol	-	-	-	-	0.89	0.86	-	-
50	14.04	trans-Dihydrocarvone	-	-	-	0.09	-	-	-	-
51	14.11	cis-Verbenone	-	-	-	-	15.80	14.62	-	-
54	14.91	trans-Shisool	-	-	-	-	0.68	0.79	-	-
56	14.97	Carvone	-	-	-	-	0.03	-	-	-

Table 2. *Cont.*

Peak Position in Chromatogram	Retention Time [min]	Component	Herb/Water							
			Lovage		Marjoram		Rosemary		Thyme	
			Control	LPGPA	Control	LPGPA	Control	LPGPA	Control	LPGPA
57	15.08	Dihydrocarveol	-	-	-	-	1.33	1.53	-	-
58	15.08	Linalyl acetate	-	-	18.28	17.89	-	-	-	-
59	15.08	Thymoquinone	-	-	-	-	-	-	0.30	0.22
60	15.12	4-Terpinenyl acetate	-	-	11.21	12.29	-	-	-	-
61	15.57	p-Mentha-1,8-dien-3-one	-	-	-	-	0.30	0.41	-	-
62	15.81	Carveol	-	-	-	-	2.17	0.36	-	-
64	15.92	Bornyl acetate	0.05	-	0.06	0.05	5.29	9.63	-	-
65	16.00	Carveol-Dup1	-	-	-	-	0.51	0.23	-	-
66	16.04	Thymol	-	-	-	-	-	-	59.32	58.20
68	16.33	Carvacrol	-	-	-	-	-	-	4.26	3.90
70	16.81	Elixene-Dup1	-	-	0.07	0.06	-	-	-	-
71	17.05	Elixene	-	-	0.78	0.65	-	-	-	-
72	17.33	α-Terpinyl acetate	24.38	20.76	-	-	-	-	-	-
74	17.53	Nerol acetate	-	-	0.10	-	-	-	-	-
75	17.68	trans-Shisool-Dup1	-	-	-	-	0.04	0.15	-	-
77	17.96	Geranyl acetate	0.23	0.06	0.17	0.16	-	-	-	-
79	18.03	Copaene	-	-	-	-	0.13	-	-	-
82	18.97	Caryophyllene	-	-	1.53	1.30	3.75	4.89	1.45	1.16
83	19.14	β-Copaene	-	-	-	-	0.06	-	-	-
86	19.52	Humulene	-	-	0.06		0.67	0.51	-	-
87	19.59	Geranyl propionate	-	-	-	-	-	-	0.12	0.11
88	19.83	Germacrene D	0.11	0.12	-	-	-	-	0.21	0.16
89	19.99	γ-Elemene	-	-	0.88	0.55	-	-	-	-
92	20.16	γ-Cadinene	-	-	-	-	0.17	0.09	-	-
93	20.20	σ-Cadinene	-	-	-	-	0.11	0.34	-	-
95	20.80	Caryophyllene oxide	-	-	-	-	0.18	0.85	-	-
96	21.03	Cubenol	0.02	0.03	-	-	-	-	-	-
97	21.21	τ-Cadinol	-	-	-	-	-	-	0.22	0.18
98	21.68	Butylidenephthalide	0.30	0.46	-	-	-	-	-	-
100	21,75	cis-Ligustilide	20.12	14.13	-	-	-	-	-	-
101.	22.10	trans-Ligustilide	29.35	34.17	-	-	-	-	-	-
Total numer of components			23	25	34	30	47	41	26	26
Yield of essential oil [mL/100g dry mass]			0.4	0.5	0.2	0.2	0.3	0.3	0.2	0.2

Essential oil extracted from lovage watered with the control water contained 23 components residing therein, with a yield of up to 0.10%. Four components, *trans*-ligustilide, α-terpinyl acetate, *cis*-ligustilide and β-phellandrene, constituted almost 95% of the total yield of isolated oil. Ligustilide, a phthalide, is efficient for treating osteoporosis and exhibits other pharmacological activities, such as anti-atherosclerosis, neuroprotection, anticancer, anti-inflammatory and analgesic activities [30,31]. On watering with LPGPA, the content of its *trans*-and *cis*-isomers increased and decreased by 6 and 5%, respectively. The content of the second abundant component of that essential oil, α-terpinyl acetate, a fragrant compound [32], increased by over 4%. The content of β-phellandrene, a fragrant cyclic monoterpene [33], decreased by about 3%. At the same time, the content of D-limonene present originally in the essential oil in the concentration of 2.82% decreased by less than 0.2%. Watering with LPGPA also resulted in over 2% increase of the content of β-pinene and by over 0.6% the content of β-ocimene. Additionally, over 3.5% γ-terpinene appeared in that oil. In the oil from the control sample, it was absent.

Watering marjoram with LPGPA also considerably changed the composition of essential oil extracted from that plant. The content of the dominating components of the oil, that is, *cis*-4-thujanol and linalyl acetate, decreased, but the content of 4-terpinenyl acetate and sabinene increased. Sabinene exhibits anti-fungal activity against pathogenic fungi [34].

In essential oil from rosemary dominated camphor, *cis*-verbenone and eucalyptol. *cis*-Verbenone is used for insect control [35] and eucalyptol serves as fragrant component, insecticide and repellent [36,37]. Watering with LPGPA generated more *cis*-verbenol. It is known as an insect pheromone [38].

Watering thyme with LPGPA decreased the content of all important components of the essential oil. Only the content of γ-terpinene, α-terpinene and β-pinene increased.

It has been documented [3] that in the preparation of LPGPA, the original macrostructure of the water declusterizes into smaller structural units. Moreover, the molecular oxygen dissolved in it is excited from its initial triplet into an excited singlet state. Therefore, excited, unstable oxygen molecules are stabilized by their surrounding with water molecules. This process provides aqueous clathrates hosting singlet oxygen. Additionally, declusterized water better solubilizes various species dissolved in it, for instance, minerals. The size of those clathrates and hydrates of solutes promoted their penetration across the cell membranes. Thus, more efficient supply of the tissues with nutrients and, first of all, with oxygen, took place. The latter could influence the metabolic processes inside the plant tissues not only as an oxidant but also as a donor of energy resulting from the transformation of the excited singlet state back into the triplet state.

4. Conclusions

Watering plantations of lovage, marjoram, rosemary and thyme with water treated with low-temperature, low-pressure glow plasma of low frequency appeared to be beneficial for the quality and yield of crops of those herbs. The effects were specific for particular cultivars. In terms of crop yield and quality, water treated with glow plasma performed best in the case of rosemary, and the worst results were observed for thyme. When the yield of essential oils was a criterion, only in the case of lovage did such watering appear beneficial. Watering the remaining herbs did not influence the yield of their essential oils. However, such watering considerably changed the composition of essential oils. These changes were specific for a given herb and involved solely the quantity of particular components of the oils. Only the essential oil from lovage was enriched with a considerable concentration of additional component, γ-terpinene, which was absent in the oil isolated from the herb watered with control water.

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