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Productivity and biochemical composition of *Mentha piperita* L. of different origin

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Biochemical composition analysis of peppermint of different origin was carried out at the Lithuanian Institute of Horticulture. *Mentha* × *piperita* L. collection samples from Lithuania and the cultivar 'Krasnodarskaya' from Ukraine were grown under the same meteorological and agrotechnical conditions. According to the data of 2006–2007, the biological properties of the plants were similar, but their productivity and chemical value differed. Peppermint of Polish origin produced the highest green herb yield (10.2–10.7 t ha^{-1}). A similar or only slightly different content of total sugar (1.78–1.94%), ascorbic acid (25.2–26.1 100 g^{-1}) and dry soluble solids (10.0–10.9%) were found in the investigated peppermints. The content of pigments directly depended on the origin of the plants. The highest content of chlorophylls (2.0 mg g^{-1}) and the lowest content of carotenoids (2.8 mg%) were found in the collection sample from Lithuania. Peppermints of Polish origin, on the contrary, produced the lowest amount of chlorophyll (1.7 mg g^{-1}) and the biggest amount of carotenoids (3.1 mg%). The indices of the cultivar 'Krasnodarskaya' were in the middle: 1.8 mg g^{-1} of chlorophyll and 3.0 mg% of carotenoids. In the raw material of peppermint of Lithuanian origin there were 0.17% of essential oils, in cultivar 'Krasnodarskaya' 0.42%, and in peppermint of Polish origin the biggest amount – 0.60%.

Key words: peppermint, *Mentha piperita* L., biochemical composition, essential oils, chlorophyll, carotenoids

INTRODUCTION

Peppermint (*Mentha piperita* L.) is a hybrid plant obtained by crossing spearmint (*Mentha spicata* L.) with water mint (*Mentha aquatica* L.). There are two peppermint forms: black (*M. piperita* L. var. *officinalis* Sole *f. rubescens* Camus) and white (*M. piperita* L. var. *officinalis* Sole *f. pallescens* Camus). Black peppermint has violet stems and leaves, and white peppermint has light green deeply cut leaves. Peppermint raw material is used in medicine, cosmetics and food industry, therefore this plant is widely grown around the world. Black peppermint produces a larget amount of essential oils and has a better aroma than the white one, thus it is more widely grown, especially for industrial processing [1, 2].

The growing of aromatic and medicine plants in our country becomes more and more popular and requires selecting the most suitable plants [3]. The black peppermint form grown in the collection of aromatic plants at the Lithuanian Institute of Horticulture was compared with the Polish peppermint of the same type and the cultivar 'Krasnodarskaya' from Ukraine. When evaluating peppermints of different origin, their productivity and biological properties were taken into account. The main index is the biochemical peppermint composition in which the most important thing is the content and quality of essential oils [4–6].

There are a lot of studies in the world about the qualitative and quantitative parameters of peppermint essential oils and the possibilities of their application. A lot of attention is paid to the evaluation of various peppermint cultivars [7–9]. A few decades ago, the suitability of peppermint of various origin for industrial growing were investigated in Lithuania [10, 11]. According to investigations of the LIH scientists, three possible *Mentha piperita* L. collection samples were selected, which might be used for the cultivation of industrial peppermint plantations.

MATERIALS AND METHODS

The object of investigation was three black peppermint plants of different origin (Lithuanian, Polish and the cultivar 'Krasnodarskaya' from Ukraine). Investigations were carried out in the turfic gleyic albic soil (VG_1^j), granulometric composition – sandy loam on light loam (according to the new classification of Lithuanian soils, calcaric epihypogleyic luvisol – IDg8-k / Calc(ar)i-Epihypogleyc Luvisols – LVg-p-w-cc [12]. The ploughing layer of the soil 22–25 cm. In the spring of 2006, in the depth of 0–25 cm it contained 1.53% of humus, 333 mg kg^{-1} of soil mobile P_2O_5 and 191 mg kg^{-1} of soil mobile K_2O, 10850 mg/kg of soil Ca, 2880 mg kg^{-1} of soil Mg. In spring, in the ploughing lay and beneath it there was found 60.5 kg ha^{-1} of mineral nitrogen ($N\text{-}NH_4$ + $N\text{-}NO_3$). Soil pH 7.6.

Investigations were carried out in 2006–2007, during the firs and second year of peppermint growth, i. e. in the most productive period. The preplant was bare fallow. In autumn, soil was deeply ploughed and in spring – leveled and cultivated. Plants

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were planted on the third decade of May 2006 in a vegetative way – by peppermint root-stocks. Planting scheme: 70 × 30 cm. The trial size 7 m^2 (1.4 × 5 m). It was made in four replications.

For the yield calculation and biochemical analyses, we used fresh peppermint herb cut during mass flowering once per vegetation. In 2006, peppermints were cut in the third decade of August, and in 2007 – in the third decade of July. Peppermint supervision was carried out according to the LIH technologies of intensive medicinal plant growing [13].

Chemical analyses were carried out at the LIH Laboratory of Biochemistry and Technology: essential oils were established by hydrodistillation method with a Clevenger type apparatus, total sugar amount by Bertran's method, dry soluble solids by refractometry, ascorbic acid by titration with 2.6-dichlorphenolindophenol sodium chloride solution, and carotenoids were determined spectrophotometrically [14–16]. Dispersion analysis of the data was fulfilled applying the ANOVA program [17].

RESULTS

The peppermint samples used in the investigations were obtained from different countries, but when growing them under the same agrotechnical and meteorological conditions their biology didn't differ. Vegetation duration, regrowth in the second year and the time of flowering of the peppermint cultivars was the same. The green herb yield of the plants was evaluated at the time of mass flowering. In 2007, peppermint produced a higher yield in comparison with the first year of growth (2006). The peppermint sample from Lithuania produced 6.9–7.9 t ha^{-1} of green herb (Table 1). Cultivar 'Krasnodarskaya' from Ukraine distinguished itself by a higher productivity (8.7–9.1 t ha^{-1}). Peppermint from Poland produced the biggest green herb yield – 10.2–10.7 t ha^{-1}. Yield differences were statistically significant.

Table 1. **Peppermint productivity**

Peppermint	Green herb yield, t ha^{-1}	
	2006	2007
From Lithuania	6.9	7.9
From Poland	10.2	10.7
'Krasnodarskaya'	8.7	9.1
LSD_{05}	1.06	1.12

Analysis of the chemical composition showed that peppermint origin almost did not influence these indices. The differences were not significant. According to the average data of 2006–2007, in peppermints of various origin there were 1.78 to 1.94% of sugar, 25.2 to 26.1 100 g^{-1} of ascorbic acid and 10.0 to 10.9% of dry soluble solids (Table 2).

Table 2. **Peppermint chemical composition, Babtai, 2006–2007**

Peppermint	Total sugars, %	Dry soluble solids, %	Ascorbic acid, mg $100g^{-1}$
From Lithuania	1.88	10.0	25.4
From Poland	1.94	10.9	26.1
'Krasnodarskaya'	1.78	10.3	25.2
LSD_{05}	0.25	1.14	2.23

Peppermint origin influenced the content of pigments. The largest content of chlorophylls (2.0 mg g^{-1}) and the lowest content of carotenoids (2.8 mg%) was found in the collection sample from Lithuania. Peppermints of Polish origin, on the contrary, distinguished themselves by the least content of chlorophyll (1.7 mg g^{-1}) and the highest level of carotenoids (3.1 mg%). The indices of cultivar 'Krasnodarskaya' were intermediate: 1.8 mg g^{-1} of chlorophyll and 3.0 mg% of carotenoids (Table 3).

Table 3. **Pigments in peppermints of various origin, Babtai, 2006–2007**

Peppermint	Chlorophylls, mg g^{-1}	Carotenoids, mg%
From Lithuania	2.0	2.8
From Poland	1.7	3.1
'Krasnodarskaya'	1.8	3.0
LSD_{05}	0.22	0.26

The biggest quantitative differences were obtained when establishing the content of essential oils in the raw material of peppermint. According to the statistically significant difference, both in 2006 and 2007 peppermint from Poland synthesized the biggest amount of essential oils (0.58–0.62%) (Table 4). Cultivar 'Krasnodarskaya' also contained high levels of essential oils (0.41–0.43). In the peppermint sample from Lithuania only 0.16–0.18% of essential oils were found.

Table 4. **The content of essential oils in peppermint green herb (%)**

Peppermint	2006	2007	Average
From Lithuania	0.16	0.18	0.17
From Poland	0.58	0.62	0.60
'Krasnodarskaya'	0.41	0.43	0.42
LSD_{05}	0.06	0.06	0.06

DISCUSSION

According to the result of investigations, peppermint productivity in 2007 may be explained by a denser peppermint field in the second year of growing. When comparing peppermint productivity results obtained in our investigations with the studies carried out in other countries, similar data were obtained. Usually peppermint green herb yield reaches 10 t ha^{-1} and in best cases exceeds this limit [18, 19].

After evaluation of the chemical composition of *Mentha piperita* L. collection samples, significant differences were obtained only in the content of essential oils. Other biochemical indices changed only slightly, usually within the limits of the least significant difference. The content of essential oils is one of the main indices of the quality of aromatic and medicinal raw material [20, 21]. Therefore, we may conclude that the peppermint sample from Poland, used in these investigations, was the best one. Abundant green herb yield (10.2–10.7 t ha^{-1}) and especially the high average content of essential oils (0.60%) are sufficient reasons for this sample of black peppermint (*M. piperita* L. var. *officinalis* Sole *f. rubescens* Camus) to be used for industrial peppermint growing.

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ĮVAIRIOS KILMĖS *MENTHA PIPERITA* L. PRODUKTYVUMAS IR BIOCHEMINĖ SUDĖTIS

Santrauka

Lietuvos sodininkystės ir daržininkystės institute analizuota skirtingos kilmės pipirmėčių biocheminė sudėtis. Vienodomis meteorologinėmis ir agrotechnikos sąlygomis auginti *Mentha piperita* L. kolekciniai pavyzdžiai iš Lietuvos ir Lenkijos, taip pat 'Krasnodarskaja' veislė iš Ukrainos. 2006–2007 m. duomenimis, biologinės tirtų augalų savybės yra panašios, tačiau jų produktyvumas ir biocheminė vertė skiriasi. Gausiausiu, 10,2–10,7 t ha^{-1}, žalios masės derliumi pasižymi lenkiškos kilmės pipirmėtės. Bendras cukraus (1,78–1,94%), askorbo rūgšties (25,2–26,1 100 g^{-1}) ir tirpių sausųjų medžiagų (10,0–10,9%) kiekis tirtose pipirmėtėse buvo panašus. Nustatyta, kad pigmentų kiekis tiesiogiai priklauso nuo tiriamųjų augalų kilmės. Daugiausia chlorofilo (2,0 mg g^{-1}) ir mažiausia karotinoidų (2,8 mg%) rasta kolekciniame pavyzdyje iš Lietuvos. Lenkiškos kilmės pipirmėtės, atvirkščiai, pasižymėjo mažiausiu chlorofilo (1,7 mg g^{-1}) ir gausiausiu karotinoidų (3,1 mg%) kiekiu. 'Krasnodarskaja' veislės rodikliai buvo tarpiniai: 1,8 mg g^{-1} chlorofilo ir 3,0 mg% karotinoidų. Lietuviškos kilmės pipirmėčių žaliavoje nustatyta 0,17%, 'Krasnodarskaja' veislės – 0,42%, o lenkiškos kilmės pipirmėtėse daugiausia – 0,60% eterinių aliejų.