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MORPHOLOGICAL AND CHEMICAL VARIABILITY OF *OCIMUM BASILICUM* L. (LAMIACEAE)

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Abstract. Morphological features of 17 sweet basil cultivars as well as essential oil content and composition were determined. The study clearly indicated great variability of *Ocimum basilicum* L. The content of essential oil in the dried herb was high and varied from 0.75% (*O. basilicum* var. *piperita*) to 1.89% (*O. basilicum* var. *cinnamon*). Based of the primary components, three chemotypes were distinguished: citral (*'Lime', 'Lemon'* and var. *citriodorum*), E-methyl cinnamate/linalool (*'Licorice'*, var. *cinnamon*) and methyl chavicol (*'Tai'*).

Key words: *Ocimum basilicum,* morphology, phytochemistry, chemotypes, essential oils

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Introduction

The genus *Ocimum* includes around 30 plant species from tropical and subtropical areas, which are much differentiated in respect of morphological and chemical features (Nurzyńska-Wierdak 2001, Vina & Murillo 2003, Telci *et al.* 2006). Among the species of the genus, *Ocimum basilicum* L. (sweet basil) is the major essential oil crop around the world, cultivated in many countries. Sweet basil is used as a spicy and medicinal herb, and the aromatic character of each type is determined by genotype and depends on the major chemical compounds of essential oil (Telci *et al.* 2006, Koba *et al.* 2009). The essential oil constituents vary among sweet basil cultivars, and the main ones are linalool, methyl chavicol, eugenol, 1,8-cineole, geranial, neral, methyl cinnamate (Nurzyńska-Wierdak 2001, 2007a, Koba *et al.* 2009, Singh *et al.* 2010). The aim of this research was to morphologically and chemically characterize 17 sweet basil cultivars.

Material and methods

The field experiment was conducted in the Experimental Farm of the University of Life Sciences in Lublin (51°23` N, 22°56` E) in 2005-2008, using the split-plot method in four replications (20 plants in each replication). The type of soil was grey-brown podzolic derived from medium loam. Climatic conditions during the vegetation period are shown in Tab. 1.

Seeds of 17 basil cultivars have been obtained from Botanical Garden of Maria Curie-Skłodowska University in Lublin (*O. basilicum* var *minimum 'Bush', O. basilicum* var. *piperita, O. basilicum* var. *cinnamon, O. basilicum* var. *citriodorum, O. basilicum* var. *lactucoefolium, O. basilicum* var. *purpurascens*), as well as from Garten Perle, Chilterns Seeds and Sutton Seeds (cvs. *'Lime', 'Licorice', 'Tai', 'New Guinea', 'Lemon', 'Sweet', 'Neapolitan', 'Rubra', 'Kardinal', 'Purpre Ruffles'* and *'Lettuce Leaf'*). Seeds were sown in the greenhouse at the beginning of April and then planted into the field about May 20th in 50×30 cm spacing. Plants at flowering stage were collected and then morphological features were determined on 24 randomly selected plants of each variety. The content of essential oil was extracted from air-dry material by distillation. Its composition was determined using gas chromatography method combined with mass detector. There were applied Varian 4000 GC-MS-MS chromatograph, equipped with a CP-8410 auto-injector and 30 m × 0.25 nm i.d. VF-5ms column (Varian, USA), film thickness 0.25 μm, carrier gas helium at the rate of 0.5 ml/

Table 1. Mean air temperature (°C) and total rainfall (mm) for May-July period in the years 2005-2008 and the long term average (1951-1995).

Month	Decade	Mean air temperature		Total rainfall	
		2005-2008	1951-1995	2005-2008	1951-1995
May	II	13.1	13.8	41.3	11.1
	III	16.2	13.8	18.1	26.0
June	I	14.7	15.4	26.0	23.1
	II	17.4	15.6	7.6	24.9
	III	18.2	16.8	10.9	23.0
July	I	19.2	17.0	8.3	20.0
	II	20.0	18.0	24.3	30.0
	III	22.5	17.6	39.0	31.0

Table 2. Characteristics of chosen growth features of studied basil cultivars.

Basil cultivar	Plant height (cm)	Plant diameter (cm)	Nr. of branches per plant	Plant weight (g)	Nr. of inflorescences per plant	Essential oil content (%)
'Kardinal'	56.9	36.6	13.0	454.1	52.0	0.85
'Lime'	39.2	41.2	13.6	135.8	26.6	1.00
'Licorice'	38.5	39.5	13.8	174.5	43.5	1.31
'Lemon'	41.8	43.4	13.3	127.3	39.9	1.18
'Lettuce Leaf'	49.8	39.8	15.6	266.7	35.8	1.10
'Neapolitan'	36.4	28.5	10.6	146.8	41.3	1.01
'New Guinea'	33.7	34.4	13.7	135.9	42.5	1.36
'Purpre Ruffles'	45.4	33.0	15.2	301.5	34.6	0.90
'Rubra'	54.0	33.2	13.2	413.5	67.8	0.82
'Sweet'	56.0	43.3	16.5	158.4	43.5	0.97
'Tai'	41.3	34.5	11.5	135.0	40.0	0.94
var. *cinnamon*	43.6	38.2	12.5	128.5	45.7	1.89
var. *citriodorum*	49.3	39.4	12.6	229.3	53.6	1.02
var. *lactucoefolium*	53.2	37.2	11.6	267.2	52.2	0.80
var. *minimum 'Bush'*	29.2	24.9	15.5	119.5	52.4	1.57
var. *piperita*	50.2	38.5	12.9	243.7	47.7	0.75
var. *purpurascens*	47.9	38.4	14.2	254.4	35.8	1.03
Mean	45.1	36.7	13.5	217.2	44.4	1.09
$LSD_{0.05}$	13.2	9.8	2.5	65.3	14.7	0.22

Table 3. Major aroma compounds of chosen basil essential oils (2005-2008).

Basil cultivar	Oil aroma and major aroma compounds of essential oil (%)
'Lime'	Aroma: lime; geranial (25.7%), neral (20.8%), linalool (10.6%), *Z-a*-bisabolene (8.0%), *E*-caryophyllene (6.2%)
'Licorice'	Aroma: licorice; *E*-methyl cinnamate (41.9%), linalool (22.7%), methyl chavicol (4.9%)
'Lemon'	Aroma: lemon; geranial (20.5%), neral (15.8%), *E*-caryophyllene (10.7%), *Z-a*-bisabolene (10.1%), linalool (9.8%), nerol (7.8%)
'Tai'	Aroma: anise; methyl chavicol (68.6%), eucalyptol (8.2%)
var. *cinnamon*	Aroma: spicy-cinnamon; *E*-methyl cinnamate (29.9%), linalool (26.5%), methyl chavicol (7.8%)
var. *citriodorum*	Aroma: citrus-fruit; geranial (20.2%), neral (15.5%), *E*-caryophyllene (10.5%), *Z-a*-bisabolene (9.9%), linalool (9.7%), nerol (7.7%)

minute; injector and detector temperature 220°C and 200°C, respectively; split ratio 1:100; injector volume 1µl. A temperature gradient was applied (50°C for 1 min, then incremented by 4°C/min to 250°C and held at this temperature for 10 min); ionization energy, 70 eV; mass range, 40-1000 Da; scan time, 0.8 s. The linear retention indices from temperature-programming, using definition of Van den Dool & Kratz (1963), were determined for series of n-alkanes C_6-C_{40}. Statistical analysis of studied features was performed using SAS software (SAS Institute Inc., Cary, NC, USA) procedures.

Results and disscusion

Significant differentiation was found in the investigated sweet basil traits relating to the plant's height, diameter, weight as well as number of branches, inflorescences and essential oil content (Tab. 2). The highest plants (56.9 cm) with the greatest weight (454.1 g) were produced by *'Kardinal'*, whereas *'Rubra'* was characterized by the largest number of inflorescences (67.8) and *'Sweet'* had a largest plant diameter and number of branches (43.3 cm and 16.5, respectively). Results of the present and earlier studies (Nurzyńska-Wierdak 2007a, b) confirm great morphological and developmental variability of sweet basil. Essential oil content was high and varied from 0.75% (*O. basilicum* var. *piperita*) to 1.89% (*O. basilicum* var. *cinnamon*) (Tab. 2). The higher content of essential oil at full bloom stage in *Ocimum* spp. has also been reported from other regions (Verma *et al.* 2011). Some these results remain consistent with those described by Seidler-Łożykowaska & Król (2008). Great variability of essential oil chemical composition was observed at chosen basil cultivars (Tab. 3). However, the main components were geranial (*'Lime', 'Lemon',* var. *citriodorum*), *E*-methyl cinnmate (*'Licorice'*, var. *cinnamon*), linalool (*'Lime', 'Licorice',* var. *cinnamon*) and neral (*'Lime', 'Lemon',* var. *citriodorum*). *'Lime', 'Lemon'* and var. *citriodorum* contained high citral (geranial and neral) contents ranging from 35.7% to 46.55% and can be considered as a citral chemotypes (Telci *et al.* 2006).

Methyl chavicol was the dominant compound in essential oil of 'Tai' plants, and was the minor component in the others. The composition of 'Tai' essential oil was similar to that described by Verma *et al.* (2011) and Koba *et al.* (2009) and indicated that this cultivar could be a potential source of methyl chavicol. Based of these primary components (compounds found in concentration higher then 15%), three chemotypes were distinguished: a) citral (*'Lime', 'Lemon'* and var. *citriodorum*); b) *E*-methyl cinnamate/linalool (*'Licorice',* var. *cinnamon*); c) methyl chavicol (*'Tai'*).

Conclusions

In conclusion, this study demonstrated the great morphological and chemical variability of *Ocimum basilicum* cultivars, and indicated that basil cultivars accumulated a relatively high percentage of essential oil (mean 1.09%) in a

Polish agro-climatic conditions. Moreover, some of the studied basil cultivars (*'Lime', 'Lemon', 'Tai',* var. *citriodorum*) seems to be interesting because of the high content of linalool, geranial and methyl chavicol.

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