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BIOLOGICAL VALUE AND ESSENTIAL OIL CONTENT IN SWEET BASIL (*Ocimum basilicum* L.) DEPENDING ON CALCIUM FERTILIZATION AND CULTIVAR

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Abstract. Within the *Ocimum* genus there occur about 200 species in different varieties and forms. They differ in the essential oil content and quality, as well as in many morphological features. The studies conducted in the years 2008–2009 were aimed at defining the effect of basil cultivar ('Kasia' and 'Wala'), as well as of the differentiated doses of $CaCO_3$ (6 or 12 g·dm^{-3} of substratum) upon the biological value and chemical composition of the oil in the examined plants, grown in pots filled with transitory peat. A significant interaction was reported between the examined cultivar and $CaCO_3$ dose upon the yield of fresh basil plant weight. The highest yield (172.3 g·plant^{-1}) was obtained from plants of 'Kasia' cultivar, when a higher dose of $CaCO_3$ was applied (12 g·dm^{-3} substratum). Lack of significant effect of calcium carbonate dose was reported upon the yield of fresh basil plant weight. In the examined objects similar fresh weight yield values were obtained. At a higher dose of calcium carbonate the unit plant weight equaled 165.9 g·plant^{-1}, and at a lower dose of $CaCO_3$ it was 160.2 g·plant^{-1}. The percentage of dry matter significantly depended on the cultivar. Basil of 'Wala' cultivar had higher dry matter content, (32.0%) compared to 'Kasia' (25.6%). Both the cultivar and calcium carbonate dose significantly affected the vitamin C contents in fresh basil herb. Increasing the $CaCO_3$ dose from 6 g·dm^{-3} to 12 g·dm^{-3} caused the increase of vitamin C concentration by 12.6%. Higher essential oil contents was characteristic of the herb of 'Kasia' plants – 1.33% compared to 'Wala' cultivar, in whose herb 1.03% of oil was determined. The qualitative composition of isolated oil depended on the examined factors. The predominating compounds were: linalool, 1.8-cineole, geranyl, D germacrene, γ-cadinene, Epi-α-cadinole. A certain differentiation was found in the contents of particular compounds in the essential oils of 'Kasia' and 'Wala' plants, as the effect of calcium nutrition.

Key words: basil, cultivar, calcium carbonate dose, herb, yield, vitamin C, chemical composition of oil

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INTRODUCTION

Ocimum – basil is a genus from *Lamiaceae* family, including about 200 species which occur in various botanic varieties and forms [Nurzyńska-Wierdak 2001]. The basil herb contains up to 1.5% of essential oil, in the composition of which the most precious compounds are linalool and eugenol. Besides it contains saponines, tannins, flavonoids and glycosides, enzymes and organic acids. The essential oil is a mixture of volatile compounds, formed and accummulated by plants in gland hairs and cells, oil tanks and ducts. It is a liquid of lipophilic nature, soluble in alcohol and lipid solvents. It has an intense smell [Strzelecka and Kowalski 2000]. Basil oil, obtained by distillation from dry herb, is one of the components of fragrance compositions applied in perfume industry. It is also used in aromatherapy. Basil herb is also vastly applied in medicine – in. a. in treating ailments of upper respiratory passages and gastritis of various types. The main germicidal and fungicidal compound occurring in basil leaves and flowers is essential oil [Politeo et al. 2007, Koba et al. 2009, Zhang et al. 2009]. In food industry it is used for aromatizing dishes and herbal liqueurs.

The concentration of essential oils in basil herb depends on various environmental factors, among which plant nutrition should be distinguished. The nutrients affecting quality and quantity of the obtained essential oil are micro- and macroelements. Studies reveal that nitrogen is an element that significantly affects the quantity of plant yield, as well as the quality of obtained raw material [Markiewicz et al. 2002, Anwar et al. 2005, Sifola and Barbieri 2006, Zheljazkov et al. 2008]. However, there are not many works in literature that concern feeding plants with the remaining nutrients, whose role in correct functioning of a plant organism is also significant. What seems especially interesting, is the effect of feeding plants with these components upon the quantity and quality of biologically active substances. For this reason studies were undertaken, which related to feeding sweet basil plants with calcium and the influence of this procedure upon the biological value of the herb. In the glasshouse experiment we examined the effect of sweet basil cultivar ('Kasia' and 'Wala'), as well as of calcium carbonate dose (6 and 12 $g \cdot dm^{-3}$) upon the fresh weight yield, vitamin C and protein concentrations, as well as the productivity and chemical composition of the essential oil of the examined plant.

MATERIAL AND METHODS

In the glasshouse experiment the sweet basil cultivars 'Kasia' and 'Wala' were grown in the following terms in the year 2008 – from 28th February to 15th May and in the year 2009 – from 10th March to 28th May. The plants grew in two-liter pots, filled with highmoor peat, limed with $CaCO_3$ in two doses: 6 and 12 $g \cdot dm^{-3}$ of substratum. The experiment was established with the use of complete randomization method in eight repetitions. The repetition was a pot with one plant. Mineral abundance of highmoor peat before the administration of nutrients was ($mg \cdot dm^{-3}$): $N\text{-}NH_4$ – tr., $N\text{-}NO_3$ – 20, $P\text{-}PO_4$ – tr., K – 6, Ca – 692, Mg – 9. The reaction of this substratum was 4.3 pH, and the general concentration of salt was 0.2 $mS \cdot cm^{-1}$. The nutrients were applied in the following amounts (g·dm^{-3} substratum): N – 0.6; P – 0.5; K – 1.0; Mg – 0.4 and (mg·dm^{-3} substratum) Fe – 8.0; Cu – 13.3; Mn – 5.1; B – 1.6; Mo – 3.7; Zn – 0.74, applying ammonium saltpeter, superphosphate (17.6% P), potassium chloride, magnesium one-water sulfate, chelate – Fe; sulfates – Cu, Mn, Zn; boric acid, ammonium molybdate.

In the experiment nutrient uptake by plants of the cultivars grown in the Institute of Natural Fibers and Herbal Plants in Poznań was assessed. Their descriptions were given in the previous paper [Dzida 2010].

The plant material for analyses was collected in the initial phase of plant flowering, at the liquidation of experiment. After harvest the height of plants was measured and they were weighed to determine the fresh weight yield. In the fresh material vitamin C content was determined with the use of Tillmans's method (PN-A-04019 1998), extract – refractometrically and after drying the dry matter was determined with the use of dryer method, protein – by Kiejdahl's method (Tecator). The content of essential oil in air-dry herb was determined in accordance with Polish Farmacopea VIII (2008). The quantitative and qualitative composition of basil oil was determined with the use of gas chromatography method and mass spectrometry (GC/MS). For the examinations we applied ITS-40 apparatus (GC/ITMS system, manufactured by Finnigan MAT, USA) with DB-5 column (J&W, USA) length: 30 m, diameter 0.25 mm and film thickness of atationary phase – 0.25 mm. The dosimeter temperature was 280ºC. Temperature gradient 35ºC was applied for 2 minutes, then increase by 4ºC to 280ºC. The qualitative analysis was performed on the basis of MS spectres, comparing them to the spectres from NIST library and terpene library LIBR (TR). The identity of compounds was confirmed by retention indexes from literature data. The statistical elaboration of results was conducted with the use of variance analysis method on mean values, applying Tukey's test for assessing differences with significance level $\alpha = 0.05$. In the tables mean values from the years 2008 and 2009 are presented.

RESULTS

The effect of the examined factors upon the yield quality and chemical composition of basil herb was presented in table 1. The highest yield (172.28 g·plant^{-1}) was obtained from plants of 'Kasia' cultivar with double dose of $CaCO_3$ (12 g·dm^{-3}). The dose of calcium carbonate had no significant effect upon the yield of fresh basil herb yield, but a higher fresh weight yield was reported at a higher calcium carbonate dose (165.92 g·plant^{-1}), as compared to half the dose of $CaCO_3$, at which the yield was on the level of 160.21 g·plant^{-1}. A significant interaction was reported between the examined cultivar and the dose of $CaCO_3$ on the yield of fresh basil plant weight .

The height of plants significantly depended upon the cultivar and interaction between the two examined factors. The plants of 'Kasia' cultivar reached the average height of 59.28 cm, and the 'Wala' cultivar – 62.5 cm.

The dry matter content significantly depended on the cultivar. The 'Wala' basil had higher dry matter content (32.02%), as compared to that of 'Kasia' cultivar (25.55%).

The examined factors, both the cultivar and calcium carbonate dose significantly affected vitamin C contents in fresh basil herb. Increasing the $CaCO_3$ dose from 6 g·dm^{-3}

to 12 g·dm^{-3} caused the increase of vitamin C concentration by 3.17 mg·100 g^{-1} f.w. (12.6%). The difference in vitamin C contents between the examined cultivars was 6.09%.

Table 1. Effect of cultivar and calcium fertilization upon herb yield, plant size and biological value of sweet basil herb (mean of the years 2008–2009)
Tabela 1. Wpływ odmiany i nawożenia wapniem na wysokość roślin, plon ziela i wartość biologiczną bazylii pospolitej (średnia z lat 2008–2009)

Cultivar Odmiana (A)	Dose of Dawka $CaCO_3$ g·dm^{-3} (B)	Fresh herb yield g·plant^{-1} Plon świeżego ziela g·roślina^{-1}	Height Wysokość cm	Dry matter Sucha masa %	Vitamin C mg·100 g^{-1} Witamina C f.m.	Extract Ekstrakt %	Protein Białko %	Essential oil Olejek eteryczny %
Kasia	6	158.42	56.57	25.80	25.52	5.20	33.67	1.40
Wala	6	162.00	63.85	31.05	18.27	5.05	33.31	1.11
Mean – Średnia B		160.21	60.21	28.42	21.89	5.12	33.49	1.25
Kasia	12	172.28	62.00	25.30	27.50	4.50	33.26	1.26
Wala	12	159.57	61.14	33.00	22.62	4.75	32.58	0.93
Mean – Średnia B		165.92	61.57	29.15	25.06	4.62	32.92	1.10
Mean for A		165.35	59.28	25.55	26.51	4.85	33.47	1.33
		160.78	62.50	32.02	20.44	4.90	32.94	1.03
$LSD_{0,05 for}$ A		i.d. – r.n.	2.515	1.663	1.010	i.d. – r.n.	i.d. – r.n.	0.191
B		i.d. – r.n.	i.d. – r.n.	i.d. – r.n.	1.010	0.219	i.d. – r.n.	i.d. – r.n.
A × B		13.693	4.752	i.d. – r.n.	1.985	i.d. – r.n.	i.d. – r.n.	i.d. – r.n.

i.d. – insignificant differences; r.n. – różnice nieistotne

The contents of extract in basil significantly depended upon the applied calcium carbonate dose. With the increase of $CaCO_3$ dose a significant fecrease of extract content in the plant was reported – by ca. 10%, whereas the decrease of protein content by about 1.7% was not statistically confirmed, and the content of essential oil decreased by 12%.

The essential oil concentration in basil herb significantly depended on the cultivars of analyzed plants. Higher essential oil content was characteristic of 'Kasia' cultivar – 1.33%, compared to 'Wala' cultivar, in which 1.03% of oil was determined. Qualitative composition of the isolated oil depended on the examined factors.

The chromatographic analysis of basil oil revealed the presence of 51 compounds (tab. 2). The predominant compounds were: linalolol, 1.8-cineol, geranyl, D germacrene, γ-cadinene, Epi-α-cadinole. A certain differentiation was found in the contents of particular gemmae of oil in plants of different cultivars and plants of different calcium nutrition. The oil of 'Wala' plants contained more 1.8-cineole, geranyl, Epi-α-cadinole than the oil of plants of 'Kasia' cultivar. The increased calcium carbonate dose caused the decrease of linalool contents from 68.85% to 59.17% and D germacrene, γ-cadinene and Epi-α-cadinole and it caused the increase of 1.8-cineole from 2.59% to 8.36% and geranyl from 2.46% to 8.1%.

Table 2. Effect of cultivar and calcium fertilization upon the chemical composition of sweet basil essential oil (mean of the years 2008–2009)
Tabela 2. Wpływ odmiany i nawożenia wapniem na skład chemiczny olejku eterycznego bazylii pospolitej (średnia z lat 2008–2009)

Compound Związek	IR	Kasia			Wala			Mean Średnia A	Mean Średnia B
		g $CaCO_3 \cdot dm^{-3}$		mean średnia	g $CaCO_3 \cdot dm^{-3}$		mean średnia		
		6 (A)	12 (B)		6 (A)	12 (B)			
α-pinene	937	0.15	0.34	0.24	0.15	0.36	0.25	0.15	0.35
camphene	954	0.06	Tr.	0.03	Tr.	Tr.	Tr	0.03	Tr.
sabinene	976	Tr.	0.27	0.13	0.06	0.29	0.17	0.03	0.28
β-pinene	981	0.16	0.78	0.47	0.27	0.79	0.53	0.21	0.78
myrcene	997	0.08	0.10	0.09	0.24	0.18	0.21	0.16	0.14
1,8-cineole	1033	2.29	8.27	5.28	2.90	8.45	5.67	2.59	8.36
E-β-ocimene	1049	0.10	0.18	0.14	0.06	0.06	0.06	0.08	0.12
γ-terpinene	1059	0.07	0.06	0.06	-	-	-	0.35	0.03
cis-sabinene hydrate	1071	0.16	0.28	0.22	0.14	0.22	0.18	0.15	0.25
terpinolene	1085	-	-	-	0.10	0.08	0.09	0.05	0.04
cis-linalool oxide	1086	0.14	Tr.	0.07	-	-	-	0.07	Tr.
fenchone	1089	0.18	0.28	0.23	0.18	0.20	0.19	0.18	0.24
linalool	1097	71.82	61.92	66.87	65.89	56.42	61.15	68.85	59.17
camphor	1152	0.56	Tr.	0.28	0.60	0.17	0.38	0.58	0.08
borneol	1179	-	-	-	Tr	0.21	0.10	-	0.10
4-ol-terpinene	1189	0.24	0.31	0.27	Tr.	0.15	0.07	0.12	0.23
α-terpineol	1207	0.25	0.66	0.45	0.24	0.75	0.49	0.24	0.70
methyl chavicol	1209	-	1.03	0.515	Tr.	1.49	0.74	-	1.26
endo-fenchyl acetate	1221	-	-	-	0.13	0.24	0.18	0.06	0.12
exo-fenchyl acetate	1222	0.09	0.16	0.12	-	-	-	0.04	0.08
geraniol	1258	2.84	5.21	4.02	2.08	10.99	6.53	2.46	8.10
bornyl acetate	1291	0.41	Tr.	0.20	0.43	0.42	0.42	0.42	0.21
α-cubebene	1351	0.09	0.07	0.08	0.09	0.05	0.07	0.09	0.06
α-copaene	1380	0.23	0.16	0.19	0.24	-	0.12	0.23	0.08
geranyl acetate	1383	1.31	0.99	1.15	0.57	2.03	1.30	0.94	1.51
β-elemene	1392	1.81	1.01	1.41	1.86	0.99	1.425	1.83	1.00
β-cubebene	1397	-	-	-	Tr.	-	-	-	-
methyl eugenol	1420	0.21	0.36	0.28	1.10	0.29	0.695	0.65	0.32
E-caryophyllene	1427	0.47	0.26	0.36	-	0.22	0.11	0.23	0.24
α-trans-bergamotene	1438	0.82	1.59	1.20	1.15	0.73	1.88	0.98	1.16
α-guaiene	1441	-	-	-	0.72	0.29	0.505	0.36	0.14
guaiene	1442	0.74	0.32	0.53	-	-	-	0.37	0.16
cis-muurola-3,5-diene	1454	-	-	-	0.17	0.19	0.18	0.08	0.09
E-β-farnesene	1459	-	-	-	0.19	-	0.09	0.09	-
α-humulene	1466	0.33	0.33	0.33	0.35	0.29	0.32	0.34	0.31
unknown	1473	0.58	0.61	0.59	0.65	0.51	0.58	0.61	0.56
D germacrene	1493	2.93	2.94	2.93	3.11	2.53	2.82	3.02	2.73
Cis-β-guaiene	1500	-	-	-	Tr.	-	-	-	-
Viridiflorene	1503	0.16	0.47	0.31	0.06	0.44	0.25	0.11	0.45
Bicyclogermacrene	1508	1.33	0.92	1.12	1.32	0.76	1.04	1.32	0.84
α-bulnesene	1513	1.17	0.44	0.80	1.32	0.46	0.89	1.24	0.45
A germacrene	1520	0.23	0.11	0.17	0.26	0.11	0.18	0.24	0.11
γ-cadinene	1524	2.83	2.86	2.84	3.31	2.56	2.93	3.07	2.71
δ-amorphene	1528	0.08	0.07	0.07	0.09	0.07	0.08	0.08	0.07
trans-calamene	1532	0.11	0.06	0.08	0.15	0.07	0.11	0.13	0.06
10-epi-cubebol	1543	0.06	0.09	0.07	0.10	0.07	0.08	0.08	0.08
α-cadinene	1547	0.06	0.06	0.06	0.07	0.06	0.06	0.06	0.06
spathulenol	1587	0.20	Tr.	0.10	0.25	Tr.	0.12	0.22	Tr.
1,10-di-epi-cubenol	1620	0.31	Tr.	0.15	1.01	0.64	0.82	0.66	0.32
Epi-α-cadinol	1653	4.27	6.12	5.19	7.82	4.92	6.37	6.04	5.52
α-cadinol	1670	0.09	0.19	0.14	0.36	0.18	0.27	0.22	0.18
Total – Suma		100.0	99.87	99.93	99.79	99.95	99.87	99.89	99.91

DISCUSSION

The yield of sweet basil, as well as its chemical composition, were differentiated depending on cultivar and calcium carbonate dose. The plants of 'Kasia' cultivar, fertilized with a greater calcium carbonate dose gave on average a higher fresh weight yield (165.9 g·plant^{-1}) with higher vitamin C content (25.1 mg·100 g^{-1} fresh weight) than plants of 'Wala' cultivar (respectively: 160.2 g·plant^{-1}, 21.9 mg·100 g^{-1}). Authors of various papers indicate that basil yield also depends on other factors. Golcz et al. [2006], as well as Golcz and Politycka [2005] report that nitrogen fertilization significantly increased basil leaf weight. Omer et al. [2008] analyzing *Ocimum americanum* L. found a higher herb and dry weight yield after applying ammonium sulfate, as compared to ammonium nitrate and urea.

The examined sweet basil plants achieved mean height of 60.893 cm. These data are similar to those given by Golcz et al. [2002] and much higher than those of Martyniak-Przybyszewska and Wojciechowski [2004]. The results in this paper indicate that the height of basil plants to a greater extent depended on the cultivar than on calcium carbonate dose.

The obtained results of vitamin C contents significantly depended upon the cultivar and calcium carbonate dose. The highest content of vitamin C (27.5 mg·100 g^{-1} fresh weight) was in the plants of 'Kasia' cultivar, which was fertilized with a larger dose of $CaCO_3$ (12 g·dm^{-3}). Martyniak-Przybyszewska and Wojciechowski [2004] obtained a lower vitamin C concentration in fresh basil weight (11.9 mg·100 g^{-1}). The authors report that the plants of sweet marjoram, thyme, summer savoury and common origanum are more abundant in this compound. Grzeszczuk and Jadczak [2008, 2009], analyzing the plants of *Lamiaceae* family, report that these plants can be stored frozen. They report that this process affects vitamin C contents destructively. Hyssop had a very high contents of this compound – 63.6 mg·100 g^{-1} before freezing. After subjecting the plants to this process the vitamin concentration decreased to 14.9 mg·100 g^{-1}. Vitamin C contents in mint plants, in turn, depended upon cultivar. The highest quantity (35.04 mg·100 g^{-1}) was obtained from plants of *Mentha piperita* L. var. *citrata* Ehrh. cultivar, the contents of the determined components in the remaining plants, reported by Grzeszczuk and Jadczak [2008] remain in consistency with those obtained from the plants of examined basil cultivars.

Concentration of essential oils in plants depends on many factors, among others upon genetic and climatic factors, manner of cultivation, harvest phase, as well as on cultivar and plant nutrition. The contents of essential oil in the examined raw material was high and significantly depended on the cultivar. The plants of 'Kasia' cultivar had greater concentrations of essential oils, as compared to those of 'Wala' cultivar. Differentiated calcium fertilization did not significantly affect the contents of oil in plants. The obtained oil concentration in herb was significantly higher than that obtained by Suchorska and Osińską [1999], Marotti et al. [1996] and Nurzyńska-Wierdak [2007].

The share of chemical compounds identified in basil oil, demonstrated on the basis of GC/MS analysis is contained in table 2. The main component of basil oil in both examined cultivars was linalool, whose contents equaled 66.9% in 'Kasia' cultivar and 61.2% in 'Wala' cultivar. On this basis both these cultivars can be included in linalool chemotype and European type according to the classification of Lawren and Suginur and Toi [after Suchorska and Osińska 1999]. A similar classification is given by Marotti et al. [1996], who define the linalool type as poorly chemically differentiated, with high content of linalool (70%), not containing methylochavicol and eugenol, but containing quite high quantity of 1.8-cyneole (13%). Of the remaining components determined in the foregoing studies, significant percentages in basil oil were these of: epi-α-cadinole (5.2% and 6.4%), geranyl (4% and 6.5%), as well as 1.8-cineol (5.3% and 5.7%). Nurzyńska-Wierdak [2007] in studies with basil of purple and green-leaved cultivars reports that the predominating compound was linalool, respectively: 73.5% and 69%. Of the remaining components the predominant share was that of: 1.8-cyneol (6.6% and 5.4%), germacrene D (2.6% and 2.5%), as well as β-elemene (2.6% and 1.8%).

CONCLUSIONS

1. No significant effect was found of cultivar and differentiated calcium carbonate fertilization upon the quantity of basil herb yield.
2. The plants of 'Kasia' cultivar had significantly higher contents of vitamin C and essential oil, as well as the lower contents of dry matter in herb, as compared to plants of 'Wala' cultivar.
3. The contents of vitamin C significantly decreased, whereas that of extract significantly increased under the influence of intense fertilization with calcium carbonate. Calcium fertilization did not affect the levels of dry matter, protein and essential oil in basil herb.
4. The predominant compound in the examined basil oils was linalool (64.01%). High concentration of this compound indicates the possibility of using basil oil as a source of natural linalool.
5. Calcium carbonate dose significantly differentiated the quantity of particular compounds in basil oil. Double dose of $CaCO_3$ caused a substantial share of 1.8-cyneole, geranyl, α-terpinolene and β-pinene in basil oil, as compared to a single dose.

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WARTOŚĆ BIOLOGICZNA ORAZ ZAWARTOŚĆ OLEJKU ETERYCZNEGO W BAZYLII POSPOLITEJ (*Ocimum basilicum* L.) W ZALEŻNOŚCI OD NAWOŻENIA WAPNIOWEGO I ODMIANY

Streszczenie. W obrębie rodzaju *Ocimum* występuje około 200 gatunków, które wykształciły liczne odmiany i formy. Różnią się one zarówno zawartością i jakością olejku eterycznego, jak i wieloma cechami morfologicznymi. Badania przeprowadzone w latach 2008–2009 miały na celu określenie wpływu odmiany bazylii (Kasia i Wala) oraz zróżnicowanej dawki $CaCO_3$ (6 lub 12 $g \cdot dm^{-3}$ podłoża) na wartość biologiczną oraz skład chemiczny olejku badanych roślin, uprawianych w doniczkach wypełnionych torfem przejściowym. Odnotowano istotną interakcję między badaną odmianą a dawką $CaCO_3$ na plon świeżej masy roślin bazylii. Najwyższy plon (172,3 $g \cdot roślina^{-1}$) otrzymano z roślin odmiany Kasia z podwójną dawką $CaCO_3$ (12 $g \cdot dm^{-3}$ podłoża). Mimo braku istotnego wpływu dawki węglanu wapnia odnotowano większy plon świeżej masy przy większej dawce węglanu wapnia (165,9 $g \cdot roślina^{-1}$) w porównaniu z mniejszą dawką $CaCO_3$, przy której plon kształtował się na poziomie 160,2 $g \cdot roślina^{-1}$. Udział suchej masy w istotny sposób uzależniony był od odmiany. Bazylia odmiany Wala charakteryzowała się większym udziałem suchej masy (32,0%) w porównaniu z odmianą Kasia (25,6%). Badane czynniki, zarówno odmiana, jak i dawka węglanu wapnia, w istotny sposób wpływały na zawartość witaminy C w świeżym zielu bazylii. Zwiększenie dawki $CaCO_3$ z 6 $g \cdot dm^{-3}$ do 12 $g \cdot dm^{-3}$ spowodowało wzrost koncentracji witaminy C o 12,6%. Wyższą zawartością olejku eterycznego charakteryzowała się odmiana Kasia 1,33% w porównaniu z odmianą Wala, w której oznaczono 1,03% olejku. Skład jakościowy wyizolowanego olejku zależał od badanych czynników. Związkami dominującymi były: linalol, 1,8-cineol, geraniol, D germacren, γ-cadinen, Epi-α-cadinol. Stwierdzono pewne zróżnicowanie zawartości poszczególnych związków olejku roślin odmian Kasia i Wala przy różnym żywieniu wapniowym.

Słowa kluczowe: plon ziela, witamina C, odmiana, dawka węglanu wapnia, skład chemiczny olejku

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