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ECONOMIC AND QUALITATIVE VALUE OF THE RAW MATERIAL OF CHOSEN SPECIES OF MEDICINAL PLANTS FROM ORGANIC FARMING
PART II. YIELD AND QUALITY OF SWEET BASIL HERB (*Ocimum basilicum* L.)*

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Abstract. In 2005-2007, in a field experiment, the yield and quality of the basil herb of the Polish cultivar Kasia in organic farming were tested. The experiment was established on six organic farms and one conventional farm in different location in Poland. The following features were evaluated: fresh and dried herb yield, stem fraction in herb, seed yield, weight of 1000 seeds, essential oil content, macro- and microelements content and microbiological purity. Only from one organic farm in Słońsk basil herb was yield higher compared with the yield from conventional cultivation, although it contained a high amount of stems. Organic basil herb was characterized by a high content of essential oil and an increased content of macro- and microelements. Evaluation of microbiological purity showed that herb contamination from both types of cultivation did not exceed the standard for raw materials treated with hot water.

Key words: essential oil, herb, microbiological purity, *Ocimum basilicum*, organic farming, sweet basil

INTRODUCTION

Sweet basil (*Ocimum basilicum* L.) has been used as a spice and medicinal plant for ages [Dachler and Pelzmann 1999]. The introduction of basil into organic cultivation will help to obtain high quality raw material, as well as an increase in the diversity of crop rotation, which is very important in organic farming [Seidler-Łożykowska et al.

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2005]. Organic herb of basil can also be used in cosmetic production or as a supplement to animal forage that can protect them against some diseases and enhance their well-being. The main aims of the experiment were testing the Polish basil cultivar Kasia for organic farming and the evaluation of its herb yield, quality, and the possibility of obtaining organic seeds.

MATERIAL AND METHODS

Information on the localisation, time, and pattern of the experiment, as well as the methods of determination of essential oil content, N-nitrate content, microbiological analyses, and statistical preparation of the results is given in the first part of the work [Seidler-Łożykowska et al. 2009].

Polish basil cultivar Kasia was examined for its usefulness for organic cultivation. Seeds were sown directly into the soil at the rate of 8 g per plot [Dachler and Pelzmann 1999]. At the beginning of basil blooming period, raw material was collected by hand from the area of 1.0 m^2 of each plot. The herbs were dried in natural conditions, in a shaded and well ventilated place.

The following traits were estimated: yield of fresh and dried herbs, fraction of stems in the herb, seed yield, weight of 1000 seeds, essential oil content, macro- and microelements content, N-nitrate content, and microbiological purity.

For the evaluation of macro- and microelement content, the plant material was subjected to „wet" mineralization:

– in a mixture of sulphosalicylic acid, sodium thiosulphate, and selenium to determine total nitrogen;
– in concentrated sulphuric acid to determine P, K, Ca, Mg, and Na;
– mixture of HNO_3 and $HClO_4$ acids in a 3:1 proportion to determine Fe, Mn, Cu, and Zn.

After plant material mineralization, the following elements were determined:

– N by distillation method according to Kjeldahl on Parnas-Wagner apparatus,
– P by colorimetric method with molybdate ammonium according to Schillak,
– K, Ca, Na by photometric method,
– Mg, Fe, Zn, Cu, and Mn by atomic absorption spectrophotometric method (AAS-3) [Nowosielski 1988, Kabata-Pendias and Pendias 1999].

RESULTS AND DISCUSSION

The average yield of fresh basil herb varied from 0.37 (Cedry) to 3.47 $kg \cdot m^{-2}$ (Słońsk). Similar average yield of air dried basil herb was from 27.4 (Cedry) to 206.4 $g \cdot m^{-2}$ (Słońsk), and both yields were significantly different (Table 1). The yields of fresh and dried herbs were also significantly different in all tested years. Stem fraction in basil herbs was considerably different as well and oscillated between 22.3 (Wiry) and 45.2% (Słońsk). Stem fraction in the total air dried yield has a strong effect on the commercial yield of herb because herb for spice is produced without stems. Following the breeder's characteristics of the basil cultivar Kasia, stem fraction should not be higher than 34% [Seidler-Łożykowska 2004]. The yield of basil organic herb from

Plewiska was lower than that from conventional cultivation but contained a similar percentage of stems.

Table 1. Basil herb yield and essential oil content
Tabela 1. Plon i zawartość olejku eterycznego w zielu bazylii

Location Miejscowość	Fresh herb yield Plon świeżego surowca $kg \cdot m^{-2}$	Air dried herb yield Plon powietrznie suchego surowca $g \cdot m^{-2}$	Stem fraction Udział łodyg %	Essential oil content Zawartość olejku eterycznego %
Bolewice (OF)	1.65 c*	118.7 c	28.7 b	2.1 ab
Cedry Wielkie (OF)	0.37 a	27.4 a	27.0 b	2.4 bc
Jary (OF)	1.54 c	112.1 c	33.4 c	2.2 ab
Słońsk (OF)	3.47 d	206.4 e	45.2 d	2.1 ab
Wiry (OF)	0.47 a	55.1 b	22.3 a	2.4 bc
Plewiska (OF)	1.14 b	109.2 c	33.3 c	2.6 d
Plewiska (CF) Control – Kontrola	1.69 c	158.0 d	34.6 c	1.9 a

a, b, c, d – values marked with the same letters do not differ significantly – wartości oznaczone tymi samymi literami nie różnią się istotnie
OF – organic farming – uprawa ekologiczna
CF – conventional farming – uprawa konwencjonalna

The average seed yield was from 2.5 (Cedry) to 21.5 $g \cdot m^{-2}$ (Plewiska) and the biggest seeds (weight of 1000 seeds) were obtained in Wiry (1.41 g) while the smallest ones in Cedry (0.99 g) (Table 2). Seed yield and the weight of 1000 seeds were significantly different in the three years of the experiment.

Table 2. Basil seed yield, weight of 1000 seeds, and nitrate content in herb
Tabela 2. Plon nasion bazylii, masa 1000 nasion oraz zawartość azotanu w zielu

Location Miejscowość	Seed yield Plon nasion $g \cdot m^{-2}$	Weight of 1000 seeds Masa 1000 nasion g	Nitrate content in herb Zawartość azotanów w zielu $mg \cdot kg^{-1}$
Bolewice (OF)	6.7 ab	1.17 bc	5250.0 c
Cedry Wielkie (OF)	2.5 a	0.99 a	1400.0 ab
Jary (OF)	20.5 c	1.26 c	4375.0 bc
Słońsk (OF)	13.4 b	1.18 bc	4054.2 bc
Wiry (OF)	8.6 ab	1.41 d	306.2 a
Plewiska (OF)	21.5 c	1.12 b	487.0 a
Plewiska (CF) Control – Kontrola	18.2 c	0.99 a	1064.8 a

objaśnienia pod tabelą 1 – for explanations, see Table 1

Positive correlation was found between fresh and air dried herb yield, while a negative correlation between stem fraction and fresh and air dried herb yield was observed (Table 3). Other investigated traits were not significantly correlated.

Table 3. Correlation coefficient between particular traits of basil
Tabela 3. Współczynnik korelacji między poszczególnymi cechami bazylii

Specification Wyszczególnienie	Fresh herb yield Plon świeżego surowca	Air dried herb yield Plon powietrznie suchego surowca	Stem fraction Udział łodyg	Essential oil content Zawartość olejku eterycznego	Seed yield Plon nasion
Dried herb yield Suchy surowiec	0.926*				
Stem fraction Udział łodyg	-0.829*	-0.833*			
Essential oil content Zawartość olejku eterycznego	-0.159	-0.130	-0.014		
Seed yield Plon nasion	0.308	0.402	-0.393	0.278	
Weight of 1000 seeds Masa 1000 nasion	-0.145	-0.157	0.110	0.379	-0.023

* significant correlation – korelacja istotna

Essential oil content ranged from 1.9 (control Plewiska) to 2.6% (Plewiska) and was high in all the years and experiments (Table 1); these results exceeded the one given by Dachler and Peltzman [1999]: 0.5-1.5%.

The content of N-nitrate in dried herb was from 306.2 (Wiry) to 5250.0 mg·kg^{-1} (Bolewice) and varied according to its origin (Table 2). Similar results were obtained by Leszczyńska [1994], who analyzed the nitrate content in the raw materials of medicinal plants of different origins. In her experiment, the range of nitrate content oscillated between 207.9 (St John's wort herb) and 16 921.0 (nettle herb) mg KNO_3·kg^{-1} d.m. Present and cited studies [Leszczyńska 1994, Nabrzyski and Gajewska 1996] showed that although the spices are used in small amounts in daily diet, the nitrate content should be regarded while the day allowance intake (ADI) is calculated.

The average content of nitrogen, phosphorus, magnesium, and some microelements (Fe, Cu, and Zn) was higher in the organic herb compared to the conventional one (Table 4).

Table 4. Content of macro- [%] and microelements [mg·kg^{-1}] in dried basil herb
Tabela 4. Zawartość makro- [%] i mikroelementów [mg·kg^{-1}] w suchym surowcu bazylii

Location Miejscowość	N	P	K	Ca	Mg	Na	Fe	Mn	Cu	Zn
Jary (OF)	2.92	0.41	5.21	2.26	0.68	0.007	307	270	19.0	143
Słońsk (OF)	3.18	0.46	2.98	3.31	0.85	0.012	554	73	17.4	110
Wiry (OF)	2.79	0.44	4.42	3.11	0.59	0.008	478	66	17.7	67
Plewiska (OF)	2.74	0.42	3.05	3.45	0.65	0.008	460	302	18.4	95
Plewiska (CF) Control – Kontrola	2.16	0.39	4.07	3.09	0.49	0.009	477	102	13.8	53

Macroelement content in the basil herb of both organic and conventional cultivations was higher compared with that cited by Marsh et al. [1976]. In the organic herb, the content of Fe and Cu was higher, while in the conventional herb, the Fe and Cu contents were lower compared with the results obtained by Marsh et al. [1976]. According to Kabata-Pendias and Pendias [1999], in Polish climatic conditions the Cu content ranged from 5-20 mg·kg^{-1} [Kabata-Pendias and Pendias 1999]. The levels of Cu

content in herbs obtained from both types of cultivation could also be placed in the ranges set by other authors [Marsh et al. 1976, Suchorska et al. 2006].

The analysis of the microbiological purity of the raw material after 6 and 12 months of herb storage showed a great diversification of the microbiological contamination of basil, depending on herb origin (Table 5). The most contaminated herb was from Bolewice and the least – from Wiry. However, all of the investigated herbs were below the level of standard contamination [Polish Pharmacopoeia 2002]. Soil and organic fertilization is the main source of the microbiological contamination of raw material [Kędzia 1999]. After 12 months of storage, the microbiological contamination of storage herb was diminished at different rates. According to Kędzia [1999], there are two main reasons for this process: 1. bacteria have different susceptibility to dryness and 2. active substances of plants (esp. essential oil, anthocyanins and tannins) have a strong effect on raw material microbes [Kędzia 1999]. Contamination of organically produced raw material should be controlled, especially for Escherichia coli content, following the fact that organic manure is a basic type of fertilization.

Table 5. Microbiological purity of basil herb after 6 and 12 months of storage
Tabela 5. Czystość mikrobiologiczna ziela bazylii po 6 i 12 miesiącach składowania

Location Miejscowość	Aerobic bacteria Bakterie tlenowe in – w 1 g		Yeasts and moulds Drożdże i pleśnie in – w 1 g		Enterobacteriaceae Enterobakterie in – w 1 g		*Escherichia coli* in – w 1 g	
	6 m.	12 m.	6 m.	12 m.	6 m.	12 m.	6 m.	12 m.
Plewiska (OF)	250 300	83 650	800	40	99 250	38 000	<10	<10
Bolewice (OF)	4 850 000	360 000	7 200	220	800 000	320 000	1 000	<10
Słońsk (OF)	505 350	56 600	247	95	181 050	23 250	<10	<10
Jary (OF)	246 150	1 400	133	10	13 450	490	<10	<10
Wiry (OF)	4 400	260	15	10	275	100	<10	<10
Plewiska (CF) Control – Kontrola	292 750	61 000	153	80	130 500	56 650	<10	<10
Standard	10 000 000		100 000		–		100	

Gross values of the obtained basil yield recalculated on 1 hectare depended on the yield obtained in the analyzed locations (Table 6). Purchasing price per 1 kg of conventional dried basil herb was used. The highest value of basil herb was obtained in Słońsk and the lowest – in Cedry.

Table 6. Gross values of basil herb yield from 1 ha, PLN
Tabela 6. Wartości brutto plonu surowca bazylii z 1 ha, zł

Location – Miejscowość	Minimum	Maximum – Maksimum
Bolewice (OF)	8 308,30	9 495,20
Słońsk(OF)	14 445,82	16 509,51
Jary (OF)	7 845,44	8 966,22
Wiry (OF)	3 901,96	4 459,38
Cedry (OF)	1 918,00	2 192,00
Plewiska (OF)	7 642,21	8 733,96
Plewiska (CF) Control – Kontrola	11 373,99	12 998,84
Price per 1 kg of herb Cena 1 kg surowca	7,00	8,00

CONCLUSIONS

1. The yield of basil herb depend more on the weather and soil conditions compare with different farming systems.
2. The quality of basil herb from organic farming (essential oil, macro- and microelements content, microbiological purity) was high but not higher than the one from conventional cultivation.
3. Satisfactory yield of basil seeds was obtained in the conditions of organic farming.
4. Basil cultivar Kasia is suitable for both organic and conventional farming.

REFERENCES

Dachler M., Pelzmann H., 1999. Arznei- und Gewürzpflazen. Agrarverlag Wien.

Kabata-Pendias A., Pendias H., 1999. Biogeochemia pierwiastków śladowych [Biogeochemistry of trace elements]. PWN Warszawa [in Polish].

Kędzia B., 1999. Badania nad zanieczyszczeniem surowców zielarskich drobnoustrojami [Studies on the contamination of herbal material with micro-organisms]. IRiPZ Poznań [in Polish].

Leszczyńska T., 1994. Azotany i azotyny w wybranych ziołach [Nitrates and nitrites in selected herbs]. Bromat. Chem. Toksykol. 27(4), 323-325 [in Polish].

Marsh A., Moss M., Murphy E., 1976. Comparison of foods: spices and herbs; raw, processed, prepared. USDA Agricultural Handbook Washington.

Nabrzyski M., Gajewska R., 1996. Zawartość azotanów i azotynów w niektórych używkach [Content of nitrates and nitrites in selected stimulants]. Bromat. Chem. Toksykol. 29(1), 59--62 [in Polish].

Nowosielski O., 1988. Zasady opracowywania zaleceń nawozowych [Rules for the preparation of fertilizer recommendations]. PIWRiL Warszawa [in Polish].

Polish Pharmacopoeia, 2002. PTF Warszawa.

Seidler-Łożykowska K., 2004. Introduction of new Polish cultivars of sweet basil (*Ocimum basilicum* L.) to cultivation. Proceeding of the 3rd Conference on Medicinal Plants, Nitra, Slovakia, 64.

Seidler-Łożykowska K., Kucharski W., Mordalski R., 2005. Ekologiczna uprawa roślin zielarskich [Organic cultivation of medicinal plants]. Centrum Doradztwa Rolniczego Radom [in Polish].

Seidler-Łożykowska K., Mordalski R., Kucharski W., Golcz A., Kozik E., Wójcik J., 2009. Gospodarcza i jakościowa wartość surowca wybranych gatunków roślin leczniczych z upraw ekologicznych. Cz. I. Plon i jakość ziela tymianku pospolitego (*Thymus vulgaris* L.) **[**Economic and qualitative value of the raw material of chosen species of medicinal plants from organic cultivation. Part I. Yield and quality of garden thyme herb**]**. Acta. Sci. Pol., Agricultura 8(3), **strony** [in Polish].

Suchorska-Orłowska J., Jadczak D., Brzostowska-Żelechowska D., 2006. Zawartość niektórych mikroelementów w wybranych gatunkach ziół [Content of some microelements in selected herb species]. Fol. Hort. 2, 174-180 [in Polish].

GOSPODARCZA I JAKOŚCIOWA WARTOŚĆ SUROWCA WYBRANYCH GATUNKÓW ROŚLIN LECZNICZYCH Z UPRAW EKOLOGICZNYCH CZ. II. PLON I JAKOŚĆ ZIELA BAZYLII POSPOLITEJ (*Ocimum basilicum* L.)

Streszczenie. W latach 2005-2007 w doświadczeniu polowym zlokalizowanym w Polsce w sześciu gospodarstwach ekologicznych i jednym konwencjonalnym badano plonowanie, jakość surowca bazylii oraz przydatność polskiej odmiany Kasia do upraw ekologicznych. Oceniano następujące cechy surowca: plon świeżego i powietrznie suchego surowca, udział łodyg w surowcu, zawartość olejku eterycznego, makro- i mikroskładników oraz azotanów, czystość mikrobiologiczną. Plon surowca bazylii pochodzącego z uprawy ekologicznej tylko z jednej lokalizacji (Słońsk) był większy niż z uprawy konwencjonalnej. Surowiec ten jednak charakteryzował się dużym udziałem łodyg. Surowiec bazylii pochodzącej z upraw ekologicznych charakteryzował się wysokimi zawartościami olejku eterycznego oraz zwiększonymi zawartościami makro- i mikroskładników. Ocena czystości mikrobiologicznej surowca bazylii wykazała, że stopień zanieczyszczenia surowców zarówno z uprawy ekologicznej, jak i konwencjonalnej nie przekraczał dopuszczalnych norm dla surowców poddawanych działaniu gorącej wody.

Słowa kluczowe: bazylia, czystość mikrobiologiczna, *Ocimum basilicum*, olejek eteryczny, uprawa ekologiczna, ziele

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