Quality of basil herb (*Ocimum basilicum* L.) from organic and conventional cultivation

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S u m m a r y

In six field experiments the quality of basil herb and usefulness of Polish cultivar 'Kasia' for organic cultivation was tested. The following features were tested: dried herb yield, stem content, essential oil content, macro- and microelements content and microbiological purity. Only basil herb yield from Słońsk was higher compared to the yield from conventional cultivation though it contained high amount of stems. Basil herb was characterized by high content of essential oil and increasing content of macro- and microelements apart from calcium. Evaluation of microbiological purity showed that for both types of cultivation herb contamination did not exceed standard for raw materials treated with hot water.

Key words: basil, herb, quality, organic cultivation, conventional cultivation

Sweet basil (*Ocimum basilicum* L.) is being used as a spice and medicinal plant for ages [1]. The introduction of basil into organic cultivation will help to obtain raw material of high quality as well as an increase in diversity of crop rotation which is very important in the organic farm [2]. Organic herb of basil can also be used in cosmetic production or as an animal forage supplement.

MATERIAL AND METHODS

The main aim of field experiments was the investigation of agro-climatic fac-

tors which affect basil yield and quality of organically produced raw material. The experiments were carried out in six different locations of Poland: Cedry Wielkie (northen), Jary and Wiry (south-western), Bolewice and Plewiska (central), Słońsk (western).

In 2005 the experiments were established in randomized complete block design in three repetitions. The area of each plot was 10 m^2. Basil cultivar 'Kasia' was examined for its usefulness for organic cultivation. Seeds were sown directly to the soil in rate of 8 g/plot [1]. Conventional cultivated raw material from Plewiska was used as a control. At the beginning of blooming period raw material was collected by hand from 1.0 m^2 area of each plot. The herbs were dried in natural conditions, in shaded and well ventilated place.

The following traits were estimated: yield of dried herb, content of stems in herb, essential oil content, macro- and microelements content, N-nitrate content and microbiological purity.

The essential oil was hydrodistillated in Dering's apparatus from herb without stems following the methods recommended by Polish Pharmacopoeia VI [3].

The plant material was subjected to „wet" mineralization:

1. in sulphosalicylic acid, sodium thiosulphate and selenium mixture in order to determine N-total by distillation method with Parnas-Wagner apparatus;
2. in concentrated sulphuric acid to determine P colorimetrically with ammonium vanadomolybdate and K, Ca, Mg, Fe, Zn, Cu, Mn by the method of atomic absorption (ASS) [4, 5].

N-nitrate content in dried herb was determined by Bremner distillation method in Starck modification after extraction in 2% acetic acid [5].

The evaluation of raw material microbiological purity was carried out in the Laboratory of Microbiology following Polish Pharmacopoeia VI standards for raw materials treated with hot water (gr. III e) [3]. Number of aerobic bacteria, number of yeasts and moulds as well as number of *Escherichia coli* was estimated in dried herb. Additionally the number of intestine bacteria from *Enterobacteriaceae* family was evaluated. Investigations were done after 6 and 12 months of storage in darkness and room temperature.

The obtained data were evaluated by analysis of variance. The mean values were compared by the use of Students' t test with the confidence level of 5%.

RESULTS AND DISCUSSION

Content of macroelements in soil and pH are presented in Table 1. The detailed data of dried mass yield, content of stems in herb, essential oil content and nitrate content are showed in table 2. The yield of dried basil herb varied from 37.5 (Cedry) to 356.2 g/m^2 (Słońsk) and was significantly different. Stem content in basil herbs was also significantly different and oscillated from 16 (Wiry) to 43% (Słońsk). The yield of herb from Słońsk contained a lot of stems and was higher

than that from conventional cultivation. Following the breeder's characteristic of basil cultivar 'Kasia' stem content should not be higher than 34% [6].

Table 1.

Results of soil analysis [mg/dm^3].

	$N\text{-}NH_4$	$N\text{-}NO_3$	P	K	Ca	Mg	pH
Plewiska	18	śl.	33	82	245	10	5,56
Słońsk	21	11	74	232	1931	257	7,79
Jary	28	śl.	19	121	189	42	6,17
Wiry	14	śl.	50	123	945	109	7,57
control	25	śl.	93	192	2469	59	7,92

Table 2.

Basil herb yield, essential oil and N-nitrate content.

locality	dried herb yield g/m^2	stem content [%]	ess. oil content [%]	$N\text{-}NO_3$ content [mg/kg s. m.]
Plewiska	205.0 d	31 c	2.05 a	1181.25
Bolewice	166.8 c	29 bc	2.05 a	5250.00
Słońsk	356.2 e	43 d	2.17 a	5818.50
Cedry W.	37.5 a	27 b	2.42 b	1400.00
Jary	108.1 b	27 b	2.12 a	875.00
Wiry	41.8 a	16 a	2.10 a	612.00
control	272.0 e	28 bc	2.20 ab	1225.00
mean	152.6	28.8	2.15	2522.80
$LSD_{0.05}$	37.30	2.48	0.273	-

Essential oil content ranged from 2.05 (Bolewice, Plewiska) to 2.42% (Cedry) and were high in all the experiments. These results exceeded the one given by Dachler and Peltzman (1999) (0.5–1.5%) [1].

The content of N-nitrate in dried herb was from 612.0 (Wiry) to 5818.5 mg/kg d. m. (Słońsk) and varied according to its origin. Similar results were obtained by Leszczyńska [7], who analyzed nitrate content in medicinal plant raw materials of different origin. In her experiment the range of nitrate content oscillated from 207.9 (St John's wort herb) to 16 921.0 mg KNO_3/kg d. m. (nettle herb). Our and the cited studies [7, 8] showed that although spices are used in small amounts in daily diet, the nitrate content should be regarded in calculating day allowance intake (ADI).

In Table 3 the content of macro- and microelements is presented. The mean content of nitrogen, phosphorus, potassium, magnesium and microelements (Fe, Mn, Cu, Zn) was higher in the organic cultivation compared to conventional, except the content of calcium. Macroelement content in basil herb of both organic and conventional cultivation was higher in comparison to that cited by Marsh et al. [9]. In organic herb the content of Fe, Mn and Cu was higher, while in conventional herb Fe and Cu content was lower in comparison to the results obtained by Marsh et al. [9]. According to Kabata-Pendias and Pendias (1999) in Polish climatic

conditions Cu content ranged from 5 to 20 mg kg^{-1} [4]. Levels of Cu content in herbs obtained from both types of cultivation could be placed in the ranges also by other authors [9, 10].

Table 3.

Macro- and microelements content in basil herb.

element	organic cultivation		conventional cultivation
	range	mean	
	%		
N	2.42 - 3.77	3.23	2.96
P	0.54 - 0.74	0.63	0.41
K	2.49 - 5.87	4.41	3.04
Ca	1.80 - 3.27	2.87	3.41
Mg	2.05 - 2.42	2.20	2.20
	ppm		
Fe	251.2 - 725.2	552.0	404.1
Mn	25.9 - 334.5	146.6	54.9
Cu	12.3 - 18.2	15.2	8.1
Zn	56.9 - 116.8	87.3	65.1

Microbiological purity of the raw material after 6 and 12 months of storage is presented in table 4. The results show a great diversification of microbiological contamination of basil, depending on herb origin. The most contaminated herb originated from Bolewice and the lowest – from Jary. Though, all of the investigated herbs were below standard contamination [3]. Soil and organic fertilization are the main sources of microbiological contamination of raw material [11]. After 12 months of storage the microbiological contamination of herb was diminished in different rates. According to Kędzia [11] there are two main reasons of this process: 1. bacteria have different susceptibility for dryness and 2. plant active substances (especially essential oil, anthocyanins and tannins) make a strong effect on raw material microbes [11]. Contamination of organically produced raw material should be controlled, especially for *Escherichia coli* content due to the fact that a basic type of fertilization is manure.

Table 4.

Microbiological purity of basil herb after 6 and 12 months of storage.

locality	aerobic bacteria in 1 g		yeasts and moulds in 1g		*Enterobacteriaceae* in 1 g		*Escherichia coli* in 1 g	
	6 m.	12 m.	6 m.	12 m.	6 m.	12 m.	6 m.	12 m.
Plewiska	402.500	165.000	2.300	70	224.000	75.000	<10	<10
Bolewice	4.850.000	360.000	7.200	220	800.000	320.000	1.000	<10
Słońsk	790.000	98.000	450	180	380.000	45.000	<10	<10
Jary	35.500	1.200	30	<10	17.000	730	<10	<10
mean	1.520.000	156.000	2.500	120	355.000	110.000	260	<10
control	220.000	120.000	400	150	130.000	113.000	<10	<10
standard	10.000.000		100.000		-		100	

CONCLUSIONS

1. Basil herb yield from Słońsk was higher compared to the yield from conventional cultivation.
2. The quality of basil herb from organic cultivation (essential oil, macro- and microelements content, microbiological purity) was high but not higher than the one from conventional cultivation.
3. Basil cultivar 'Kasia' is suitable for both organic and conventional cultivation.

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OCENA JAKOŚCI SUROWCA BAZYLII POSPOLITEJ (*OCIMUM BASILICUM* L.) POCHODZĄCEGO Z UPRAW EKOLOGICZNEJ I KONWENCJONALNEJ

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S t r e s z c z e n i e

W sześciu doświadczeniach polowych badano jakość surowca bazylii oraz przydatność jej polskiej odmiany do upraw ekologicznych. Oceniano następujące cechy surowca:

plon suchego surowca, udział łodyg w surowcu, zawartość olejku eterycznego, makro- i mikroskładników oraz azotanów, czystość mikrobiologiczna. 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 pochodzący z upraw ekologicznych charakteryzował się wysokimi zawartościami olejku eterycznego oraz zwiększonymi zawartościami makro- i mikroskładników z wyjątkiem wapnia. 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, surowiec, jakość, uprawa ekologiczna, uprawa konwencjonalna