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ECONOMIC AND QUALITATIVE VALUE OF THE RAW MATERIAL OF CHOSEN SPECIES OF MEDICINAL PLANTS FROM ORGANIC FARMING PART I. YIELD AND QUALITY OF GARDEN THYME HERB (*Thymus vulgaris* L.)*

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Abstract. In 2005-2007, in a field experiment, the yield and quality of the thyme herb of the Polish cultivar Słoneczko in organic farming were tested. The experiment was established on six different organic farms and one conventional farm in Poland. The following features were evaluated: fresh and dried herb yield, stem fraction in herb, essential oil content, and microbiological purity. Only from one organic farm in Słońsk thyme herb yield was higher compared with the yield from conventional cultivation, although it contained a high amount of stems. Organic thyme herb was characterized by a high content of essential oil. 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, organic farming, thyme, *Thymus vulgaris*

INTRODUCTION

Garden thyme (*Thymus vulgaris* L.) is one of the most important medicinal plants cultivated in Poland. Herb of thyme (*Herba Thymi*) collected at flowering time is the raw material. In Poland, thyme cultivar Słoneczko has been widely introduced into cultivation. This cultivar gives the yield of 2.5-3 $t \cdot ha^{-1}$ of dry herb in the second year; the content of essential oil – 1.6%; 90% of flowers are male fertile; yield of seed app.

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100 kg·ha^{-1}. Beside its medical value, thyme is commonly used as a spice [Dachler and Pelzmann 1999, Seidler-Łożykowska and Kaźmierczak 2001]. The introduction of thyme into organic cultivation (farming) 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. 2005]. Organic herb of thyme can also be used in cosmetic production or as forage for animals that can enhance their well-being. The main aims of the experiment were testing the Polish thyme cultivar Słoneczko for organic cultivation and the evaluation of its herb yield and quality.

MATERIAL AND METHODS

The experiment was carried out on six certified organic farms located in: Cedry Wielkie (52°14' N; 18°50' E), Jary (51°17' N; 16°52' E), Wiry (50°50' N; 16°38' E), Bolewice (52°23' N; 16°07' E), Plewiska (52°21' N; 16°48' E), Słońsk (52°33' N; 14°48' E). Comparative field ran according to the rules of conventional farming was established in Plewiska (52°21' N; 16°48' E).

In 2005-2007 the experiments were established as a randomized complete block design in three repetitions. Each plot had 10 m^2. Polish thyme cultivar Słoneczko was examined for its usefulness for organic cultivation. Seeds were sown directly into the soil at the rate of 6 g per plot [Dachler and Pelzmann 1999]. At the end of August, 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. Raw material from conventional cultivation from Plewiska was used as a control (CF in the tables).

The following traits were estimated: yield of fresh and air dried herbs, stem fraction in dried herb, essential oil content, N-nitrate content, and microbiological purity.

Essential oil was hydrodistillated from herb without stems with Dering's apparatus, following the methods recommended by Polish Pharmacopoeia VI [2002].

N-nitrate content in dried herb was determined by the Bremner distillation method in a modification done by Starck after an extraction in 2% acetic acid [Nowosielski 1988].

In Microbiology Laboratory, the evaluation of raw material microbiological purity was carried out following Polish Pharmacopoeia VI standards for raw materials treated with hot water (gr. III e) [Polish Pharmacopoeia 2002]. Number of aerobic bacteria, yeasts and moulds, and the number of *Escherichia coli* were estimated in dried herb. Additionally, the number of intestine bacteria from family *Enterobacteriaceae* was evaluated. Investigations were done after 6 and 12 months of herb storage in darkness at room temperature.

The obtained data was calculated using the method of the analysis of variance with the use of F-Fisher's test for two-way classification for years and location without interaction between years and location. The mean values were compared with the use of Student's t-test with the confidence level of 5%. Homogenous groups were constructed on the basis of LSD test.

RESULTS AND DISCUSSION

The average yield of fresh thyme herb varied from 0.43 (Wiry) to 3.49 kg·m^{-2} (Słońsk). Similar average yield of air dried herb was from 44.7 (Wiry) to 338.1 g·m^{-2}

(Słońsk), and all yields of herb were significantly different (Table 1). The yield of air dried herb was also significantly different in all tested years. Stem fraction in thyme herbs was considerably different and oscillated between 34.3 (Wiry) and 47.4% (Słońsk). Stem fraction in total dried yield has a strong effect on the commercial yield of herb because herb for spice is produced without stems. Following the breeder's characteristic of the thyme cultivar Słoneczko, stem fraction should not be higher than 40% [Seidler-Łożykowska 2005]. The yield of fresh organic herb from Plewiska was lower than that from conventional cultivation but the yield of dried herb was higher because the control contained more stems.

Table 1. Thyme herb yield, essential oil, and N-nitrate content
Tabela 1. Plon oraz zawartość olejku eterycznego i azotanu w zielu tymianku

Location Miejscowość	Fresh herb yield Plon świeżego surowca $kg \cdot m^{-2}$	Dried herb yield Plon suchego surowca $g \cdot m^{-2}$	Stem fraction Udział łodyg %	Essential oil content Zawartość olejku eterycznego %	Nitrate content Zawartość azotanów $mg \cdot kg^{-1}$
Bolewice (OF)	1.02 bc	90.2 abc	39.0 bc	2.2 a	250.0
Cedry Wielkie (OF)	0.63 ab	73.6 ab	37.7 ab	1.9 a	trace – ilość śladowa
Jary (OF)	1.24 c	88.1 abc	42.6 c	2.6 b	trace – ilość śladowa
Słońsk (OF)	3.49 d	338.1 d	47.4 d	2.8 c	118.5
Wiry (OF)	0.43 a	44.7 a	34.3 a	2.0 a	trace – ilość śladowa
Plewiska (OF)	1.13 c	127.6 c	37.6 ab	2.5 b	trace – ilość śladowa
Plewiska (CF) Control – Kontrola	1.39 c	116.3 bc	39.0 bc	2.9 c	425.0

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

Essential oil content in dried herb ranged from 1.9% (Cedry) to 2.9 (control Plewiska) and was very high in all the years and experiments (Table 1); these results exceeded the one given by Dachler and Peltzman [1999]: 1.2%. Also a high content of essential oil originated from Słońsk was noted – 2.8%. Statistical analysis showed that the essential oil content in all years was significantly different.

From most locations, the content of N-nitrate in dried thyme herb was from trace (Cedry, Wiry, Jary, Plewiska) to 425.0 $mg \cdot kg^{-1}$ (control Plewiska) (Table 1). 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 from 207.9 (St John's wort herb) to 16 921.0 (nettle herb) mg $KNO_3 \cdot kg^{-1}$ d.m. Present and cited studies [Leszczyńska 1994, Nabrzyski and Gajewska 1996] showed that although spices are used in small amounts in daily diet, the nitrate content should be regarded while the day allowance intake (ADI) is calculated.

Positive correlation was found between fresh and air dried herb yields, while a negative correlation between stem fraction and fresh and air dried herb yields was observed (Table 2). Other investigated traits were not significantly correlated.

Table 2. Correlation coefficient between particular traits of thyme
Tabela 2. Współczynnik korelacji między poszczególnymi cechami tymianku

Specification Wyszczególnienie	Fresh herb yield Plon świeżego surowca	Dried herb yield Plon suchego surowca	Stem fraction Udział łodyg
Dried herb yield Suchy surowiec	0.841*		
Stem fraction Udział łodyg	-0.763*	-0.638*	
Essential oil content Zawartość olejku eterycznego	0.401	0.118	-0.518

* significant correlation – korelacja istotna

The analysis of the microbiological purity of the raw material after 6 and 12 months of herb storage showed a great diversification of microbiological contamination of thyme, depending on herb origin (Table 3). The most contaminated herb was from Jary and Słońsk, while the least – from Bolewice. However, all of the investigated herbs were below the level of standard contamination for the raw material treated with hot water [Polish Pharmacopoeia 2002]. Soil and organic fertilization are the main sources of microbiological contamination of raw material [Kędzia 1999]. After 12 months of storage, the microbiological contamination of storage thyme 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 3. Microbiological purity of thyme herb after 6 and 12 months of storage
Tabela 3. Czystość mikrobiologiczna ziela tymianku 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)	220 350	25 000	65	32	1 625	700	<10	<10
Bolewice (OF)	41 500	29 000	20	10	4 050	100	<10	<10
Słońsk (OF)	550 000	117 850	2 550	105	61 650	7 950	<10	<10
Jary (OF)	580 000	145 000	20	10	39 500	3 400	<10	<10
Wiry (OF)	390 000	66 000	20	20	2 025	6 500	<10	<10
Cedry (OF)	430 000	32 000	420	10	91 000	100	<10	<10
Plewiska (CF) Control – Kontrola	375 100	31 7500	150	60	18 250	3 350	<10	<10
Standard	10 000 000		100 000		–		100	

OF, CF – objaśnienia pod tabelą 1 – for explanations, see Table 1

Gross values of the obtained thyme yield recalculated on 1 hectare depended on the yield obtained in the analyzed locations (Table 4). Purchasing-price per 1 kg of conventional dried thyme herb was used. The highest value of thyme herb was obtained in Słońsk and the lowest – in Wiry.

Table 4. Gross values of thyme herb yield from 1 ha, PLN
Tabela 4. Wartości brutto plonu ziela tymianku z 1 ha, zł

Location – Miejscowość	Minimum	Maximum – Maksimum
Bolewice(OF)	3 606,27	5 409,40
Słońsk (OF)	13 525,96	20 288,93
Jary (OF)	3 522,80	5 284,20
Wiry (OF)	1 789,73	2 684,60
Cedry (OF)	2 944,40	4 416,60
Plewiska(OF)	5 104,93	7 657,40
Plewiska (OF) Control – Kontrola	6 048,71	9 073,07
Price per 1 kg of herb Cena 1 kg ziela	4,00	6,00

CONCLUSIONS

1. Only thyme herb yield from one organic farm was higher compared with the yield from conventional cultivation.
2. The quality of thyme herb from organic farming (essential oil and microbiological purity) was high but not higher than the one from conventional cultivation.
3. Thyme cultivar Słoneczko is suitable for both organic and conventional farming.

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GOSPODARCZA I JAKOŚCIOWA WARTOŚĆ SUROWCA WYBRANYCH GATUNKÓW ROŚLIN LECZNICZYCH Z UPRAW EKOLOGICZNYCH CZ. I. PLON I JAKOŚĆ ZIELA TYMIANKU POSPOLITEGO (*Thymus vulgaris* L.)

Streszczenie. W latach 2005-2007 w doświadczeniu polowym zlokalizowanym w Polsce w sześciu gospodarstwach ekologicznych i jednym konwencjonalnym badano plonowanie, jakość surowca tymianku oraz przydatność polskiej odmiany Słoneczko do upraw ekologicznych. Oceniano następujące cechy: plon świeżego i powietrznie suchego ziela, udział łodyg w surowcu, zawartość olejku eterycznego oraz czystość mikrobiologiczną. Plon surowca tymianku pochodzącego z uprawy ekologicznej tylko z jednej lokalizacji (Słońsk) był większy niż z uprawy konwencjonalnej. Surowiec ten jednak charakteryzował się dużym udziałem łodyg. Surowiec tymianku pochodzący z upraw ekologicznych charakteryzował się wysoką zawartością olejku eterycznego, jednak była ona mniejsza niż ziela z upraw konwencjonalnych. Ziele pochodzące z uprawy konwencjonalnej zawierało najwięcej azotanów. Ocena czystości mikrobiologicznej surowca tymianku wykazała, że stopień zanieczyszczenia surowców zarówno z uprawy ekologicznej, jak i konwencjonalnej nie przekraczał dopuszczalnych norm dla surowców poddawanych działaniu gorącej wody.

Słowa kluczowe: czystość mikrobiologiczna, olejek eteryczny, *Thymus vulgaris,* tymianek, uprawa ekologiczna, ziele

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