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Research article

Antioxidant potential of selected herbal plants from various cultivation systems for cosmetic purposes

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Abstract: *The aim of this study was to determine the value of the antioxidant potential of several domestic herbal plant species derived from conventional and organic crops, which, due to the content of valuable biologically active compounds with anti-inflammatory properties, can be used in the production of cosmetic preparations. The antioxidant potential of methanol extracts of the tested plants was determined using the FRAP method with ascorbic acid as a standard. The content of antioxidants in the studied plants ranged from 1.121 to 13.228 mg/g for samples from conventional crops and from 1.559 to 19.327 mg/g for samples from organic farming. Greater biological value of extracts obtained from plants grown in an organic system than in a conventional systemhas been indisputably demonstrated. The obtained research results may constitute an incentive for producers of cosmetics to choose native organic plants for the production of their products.*

Keywords: *herbal plants; spice plants; antioxidant properties; cosmetic purpose*

Introduction

Herbal and spice plants are a rich and not yet fully researched source of valuable biologically active compounds. Despite the growing interest of the cosmetics industry in this group of raw materials observed in recent years, their application potential still remains unused. However certified organic cosmetics are gradually increasing their share in the cosmetics market, which is clearly visible both on the domestic and global market [1-3]. A similar upward trend is observed in the area of organic farming food products [4]. Scientific research confirms the greater biological value of plants and food of organic origin in relation to the products of conventional agriculture [5, 6]. For this reason, cosmetics producers are also eager to use ecological plant extracts.

Antioxidants are an extensive group of biologically active compounds that delay or stop the oxidation processes. These compounds used in cosmetic

products have two functions - they protect lipid ingredients and final cosmetics against auto-oxidation processes, extending their stability, and on the other hand, they are active ingredients of the product, preventing damage to skin lipids, collagen, elastin, and DNA strands. For this reason, cosmetic manufacturers are eager to use natural antioxidants in cosmetics dedicated to mature skin with signs of aging. The most commonly used antioxidants in the cosmetics industry are tocopherols, ascorbic acid and its derivatives, and synthetic butylated hydroksytoluene (BHT), butylated hydroxyanisole (BHA) or tert-butyl hydroquinone (TBHQ). However, due to reports on their adverse effects, a shift from synthetic to natural antioxidants has been observed for several years [7, 8].

An alternative to synthetic antioxidants in cosmetics can be herbal plant extracts. They not only have a protective function for the cosmetic preparation, but also have a beneficial effect on the skin. Domestic cosmetics producers, trying to attract the attention of consumers, eagerly reach for exotic raw materials, forgetting about domestic plants, which often have a richer composition of active compounds.

Four species of domestic herbal plants, rarely found in cosmetic preparations, i.e. dill (*Anethum graveolens* L.), parsley (*Petroselinum crispum*), lovage (*Levisticum officinale*) and peppermint (*Mentha x piperita* L.) from organic and conventional cultivation, were selected for this study. The aim of the study was to determine the value of the antioxidant potential of these plants depending on the type of cultivation and the possibility of using them in cosmetic products.

Experimental

Materials

Four domestic species of herbal plants (dry leaves), from conventional and organic crops, purchased in a local store in Łódź, were selected for the study, i.e. dill (*Anethum graveolens* L.), parsley (*Petroselinum crispum*), lovage (*Levisticum officinale*) and peppermint (*Mentha x piperita* L.).
All the chemicals used for the analysis were an analytical grade.

Methods

The antioxidant potential of plant extracts was determined by the spectrophotometric FRAP method (Ferric ion Reducing Antioxidant Power) [9], based on the ability of antioxidants to reduce Fe^{3+} ions to Fe^{2+} in a complex with TPTZ (2,4,6-tris (2-pyridyl) -1,3,5-triazine). Absorbance of the resulting blue complex was recorded at 593 nm. Total antioxidant content of studied herbs was calculated in relation to the standard curve prepared for ascorbic acid (AA).

Preparation of plant extracts

All herbs selected for the study were milled and then weighed in three replications, i.e. three weights of organic and three weights of conventional herbs were prepared, which gave a total of 6 samples for one species and a total of 24 samples for all the tested herbs. Each sample weighed approximately 0.25 g.

Then, the methanol extracts of the tested plants were prepared by adding 5 ml of 80% (v/v) methanol to each sample of herbs. The samples were placed on a laboratory cradle (J.W. Electronic KL-942) for 1h (room temperature) for antioxidant extraction. Then they were centrifuged on a centrifuge (MPW-251; 14,000 rpm; 10 min) and the supernatant was collected, which was the appropriate extract for further research.

Preparation of reaction mixtures and determination of antioxidants

For each sample, a reaction mixture was prepared consisting of 1.65 mL of sodium acetate solution (0.3 mol/L), 0.165 mL of iron (III) chloride solution (20 mmol/L), 0.165 mL of TPTZ solution (10 mmol/L) and 15 µL of the plant extract. Solutions were mixed thoroughly and incubated at 37 ºC for 4 minutes. Additionally, a blank sample was prepared according to the same procedure, which instead of the plant extract contained 15 µL of 80% (v/v) methanol. The solutions for the standard curve were prepared similarly as above, where 15 µL of successive concentrations of AA were introduced instead of the plant extract. The absorbance of the plant samples and of the samples for the standard curve was measured against the blank sample on the spectrophotometer (Hewlett Packard, Agilent HP-8453 UV-Visible Spectrophotometer) for a wavelength of 593nm. Total antioxidant content (AntiOX) of studied herbal plants was calculated from the standard curve equation. Moreover, the value of the standard deviation (SD) for the determined values of AntiOX of all tested herbs was calculated with Microsoft 365 Excel.

Results and Discussion

The total content of antioxidants in the studied herbs was calculated on the basis of the standard curve equation of FRAP assay presented in Figure 1 and the following equation:

$$\mathrm{AntiOX} = \frac{\mathrm{A} \cdot 5}{1.9881 \cdot \mathrm{n}}$$

where: AntiOX – antioxidant content [mg/g], A – sample absorbance, 5 - volume of methanol added to the weight of herb [mL], 1.9881 – the slope of the standard curve equation, n - weight of the herb [g].

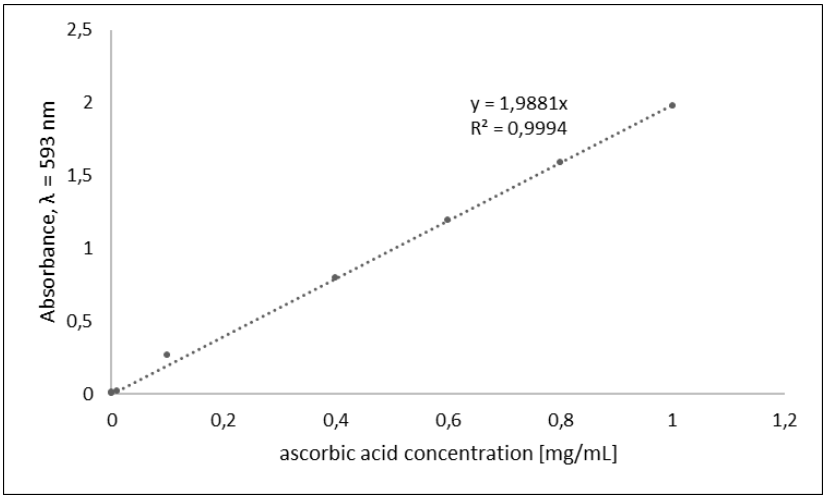

Figure 1. Standard curve of FRAP assay

Table 1 shows the absorbance values and the content of antioxidants in the tested plants depending on the type of plant cultivation (organic or conventional).

Table 1 The value of absorbance (A) and the antioxidant content (AntiOX) in the studied plants depending on the type of crop

Species -Latin name (common name)	Type of cultivation	A (593 nm)	AntiOX [mg/g]	Average AntiOX content [mg/g]	Standard deviation (SD)
***Anethum graveolens* L.** (dill)	**organic**	1.438	14.155	14.514	0.633
		1.480	14.141		
		1.556	15.245		
	conventional	1.148	10.833	9.788	0.906
		0.949	9.316		
		0.919	9.215		
Petroselinum crispum (parsley)	**organic**	1.358	12.722	12.878	0.336
		0.884	12.648		
		0.867	13.263		
	conventional	0.603	4.947	5.332	0.376
		0.590	5.348		
		0.504	5.700		
Levisticum officinale (lovage)	**organic**	1.290	18.580	19.327	2.383
		2.252	17.407		
		1.757	21.995		
	conventional	1.496	14.685	13.228	1.592
		1.090	13.469		
		1.371	11.529		
***Mentha x piperita* L.** (peppermint)	**organic**	0.144	1.416	1.559	0.177
		0.135	1.757		
		0.179	1.505		
	conventional	0.112	1.150	1.121	0.057
		0.124	1.068		
		0.128	1.179		

The comparison of the antioxidant potential of the studied plants is shown in Figure 2.

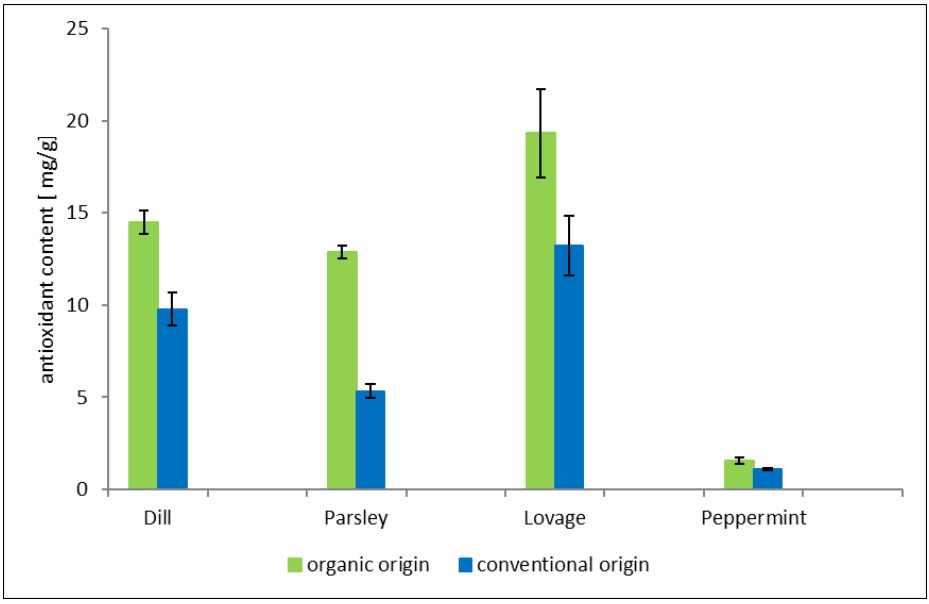

Figure 2. Average content of antioxidants in the studied herbs depending on the type of cultivation

For all studied plant species, a higher content of antioxidants was observed for the organic samples compared to the conventional ones. It confirms the results of research conducted by other researchers on plants derived from organic farming [10]. The highest content of antioxidants was recorded for lovage from organic farming (19.327 ±2.383 mg/g), while conventional lovage contains 31.56% less antioxidants (13.228 ±1.592 mg/g). Organic dill has a slightly lower antioxidant potential (14.514 ±0.633 mg/g), and that of conventional cultivation is 32.56% lower (9.788 ±0.906 mg/g). A similar content of antioxidants was found in organic parsley leaves (12.878 ±0.336 mg/g), but much lower in conventional parsley (5.332 ±0.376 mg/g), i.e. by as much as 58.59% less. The significantly lowest antioxidant content was found in the peppermint, 1.559 ±0.177 mg/g and 1.121 ±0.057 mg/g for the organic and conventional samples, respectively.

Conclusions

Based on the conducted research, it can be concluded that selected species of domestic herbal and spice plants are a valuable source of antioxidants. Among the studied species, the extracts of lovage, dill and parsley leaves have the highest antioxidant potential. Plants from organic crop contain much more antioxidants (on average 37.95% more) than those obtained from conventional

cultivation. Organic lovage, dill and parsley extracts can be a valuable ingredient for cosmetic purposes.

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