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Productivity, Biochemical Indices and Antioxidant Activity of Peppermint (*Mentha Piperita* L.) and Basil (*Ocimum Basilicum* L.) in Conditions of Hydroponics

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Abstract

Dry raw material of both peppermint and sweet basil grown with the application of different hydroponic methods (cylindrical, gully, continuous, classical) exceeds soil culture 1.2-2.7 and 1.8-2.7 times. At the same time a high output (1.6-3.1 times) of secondary origin bioactive substances was observed in cylindrical and classical hydroponics systems due to the high productivity of peppermint and in the case of basil in cylindrical hydroponics system (1.2-2.9 times).

For determining antioxidant activity from different quantity of alcoholic extracts obtained from the mentioned plants the more effective is chosen in peppermint 5.0 mg/ml in which case free radical oxidation process of lipids is repressed from 68% to 84%, and in case of basil 1.0 mg/ml from 23% to 31%.

Keywords: Water-stream hydroponics; Peppermint: Sweet basil: Extractives; Antioxidant; Productivity

Introduction

Environmental pollution threatens the health of humans, and can also disturb plant and animal diversity. It causes normal activity deterioration of biosystems [1,2].

Nowadays, antioxidants, which are an integral part of biologically active substances, are of great interest. They can reduce mutagenic influence, regulating the oxidation process of free radicals. Therefore, discovery and studies of natural sources with antioxidant activity is an urgent problem now. According to literature, a number of biologically active substances, which are produced by plants and have antioxidant activity, are known. They include α-tocoferol (vitamin E), tannins, ascorbic acid (vitamin C), β- carotene (5), a number of protein compounds with enzymatic activity, flavonoids, polysaccharides, terpenoids, polyphenol compounds and etc [3-8].

Similar studies were also carried out in *Hypericum perforatum* L., *Thymus marschalliamus* (Willd) and *Callisia fragrans* (Lindl) Woodson plant raw material grown in soilless culture (hydroponics) conditions. The extracts of the tested samples had a positive antiradical activity [9-11].

Antioxidants are widely used in medicine, agriculture, as well as chemistry and food industry. Lack of antioxidants in organism, as stated above, promotes the oxidation process activity of free radicals, which in turn causes a variety of pathological conditions and for development. Regulation of antioxidant levels promotes prolongation of life expectancy, strengthens the immune system.

Peppermint (*Mentha piperita* L.) and sweet basil (*Ocimum basilicum* L.) are among the most popular essential oil and medicinal plants, which are widely used in medicine, pharmaceutics and perfume production. At the same time, they are used as a spice (in the form of tea) and have antioxidant properties [12,13].

Taking into account the unique properties of peppermint and sweet basil, our aim is to study the comparative description of productivity, biochemical indices and antioxidant properties of these plants, grown in water stream hydroponics[1] (cylindrical, gully, continuous), classical hydroponics and soil culture (control) conditions.

Material and Methods

Planting material of peppermint and sweet basil, obtained with hydroponics method, were used during the experiments. 3-15 mm particle diameter volcanic slag was used as a substrate in all the hydroponics systems. The plants were nourished with G.S. Davtyan's nutrient solution [14]. The content of essential oil, extractives, tannins in dry raw material was determined with SPh XI [15], flavonoids with Borisov's method [16], the antioxidant activity (AO) of plants in extractives was determined with malonic dialdehyde quantitative determination method [17].

In order to determine antioxidant activity of peppermint and sweet basil different dosages (0.5; 1.0; 2.0; 5.0 և 10.0 mg/ml) of extractives was taken from the mentioned plants. Among them, 5.0 mg/ml was chosen as the most effective variant for peppermint and 1.0 mg/ml for sweet basil. The studies were carried out in liver homogenate, lipid peroxidation processes were activated with the application 0.5 ml (15.7

[1]Developing new and low cost hydroponics systems is one of the most important issues for increasing the economic efficiency of plant soilless culture and its wide spread in the world. The most promising among them is water-stream hydroponics system developed in Institute of Hydroponics Problems NAS RA the result of 25-year investigations, with use of polymer film which enables to sharply decrease (5-6 times) expenditures for building a hydroponicum [19-21].

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mg/l) water solution of Mohr's Salt (MS) [$FeSO_4 \bullet (NH_4)_2SO_4 \bullet 6H_2O$] Alcoholic extracts of peppermint and sweet basil were used as possible antioxidants.

The number of experiment replications was 4-8, mathematical modeling was done according to Dospekhov [18].

Results and Discussion

Growth peculiarities and productivity indices of the studied plants in hydroponics and soil culture conditions vary significantly. It is the result of regulating a number of factors, particularly food-air-water mode, which provide growth, development and productivity of hydroponics plants. We can see from the analysis of Tables 1 and 2 that planting material of both peppermint and sweet basil, obtained with application of different hydroponics methods, exceeded soil culture 1.2-2.7 and 1.8-2.7 times with dry weight. At the same time, due to high productivity of peppermint, maximum output of essential oils (1.6-2.6 times), extractives (1.7-3.1 times), flavonoids (1.6-2.3 times) and tannins (1.6-2.8 times) was provided by cylindrical and classical hydroponics systems. In case of sweet basil the output (per plant) of the above mentioned compounds, except tannins, increases 1.2-2.7; 1.5-2.8; 1.3-2.9 times, respectively, compared to the other tested variants.

It is obvious from the analysis that cultivation conditions affected peppermint antioxidant activity. Planting material grown in cylindrical and continuous hydroponics systems had less antioxidant properties; it was inferior to other variants 1.6 - 1.9 times. While, in case of sweet basil the difference is not significant. However, free radical oxidation processes of lipids were repressed in both cases. In case of peppermint it is 68% to 84% and in case of sweet basil 23% to 31% (Figure 1). It is also neccessary to note that high productivity of the crops tested in cylindrical hydroponics system, in turn, promoted the output increase of the above mentioned compound 1.6 - 4.9 and 1.2 - 2.6 times.

Conclusion

Dry raw material of both peppermint and sweet basil obtained with the application of different hydroponic methods exceeds soil culture 1.2-2.7 times.

A high output (1.2-3.1 times) of secondary origin bioactive substances was obtained in plant raw material of peppermint and sweet basil grown in different hydroponics systems.

Peppermint and sweet basil grown in conditions of different

Variant	Dry weight of medicinal raw material, g/plant	Essential oil		Extractives		Sum flavonoids		Tannins	
		%	g/plant	%	g/plant	%	g/plant	%	g/plant
Cylindrical	155.0	3.98	6.15	20.63	32.0	2.80	4.3	14.76	22.9
Gully	83.7	4.16	3.48	18.16	15.2	3.0	2.5	13.96	11.7
Continuous	69.7	3.93	2.74	20.20	14.1	3.16	2.2	14.34	10.0
CH	149.0	3.80	5.66	17.23	25.7	2.66	4.0	12.56	18.7
Soil (control)	57.0	4.09	2.33	18.07	10.3	3.26	1.9	14.63	8.3
LED_{05}	15.3	-	-	-	-	-	-	-	-
*Average data of three cuts are shown									

Table 1: Content and output of substances determining pharmaco-chemical value of peppermint in conditions of different hydroponics systems and *soil culture.

Variant	Dry weight of medicinal raw material, g/plant	Essential oil		Extractives		Sum flavonoids		Tannins	
		%	g/plant	%	g/plant	%	g/plant	%	g/plant
Cylindrical	85.3	0.77	0.66	26.78	22.84	2.72	2.32	8.72	7.44
Gully	75.2	0.74	0.56	18.45	13.87	2.10	1.58	10.36	7.79
Continuous	57.4	0.82	0.47	26.25	15.07	2.44	1.40	10.81	6.20
CH	61.3	0.60	0.37	25.28	15.50	2.91	1.78	8.18	5.01
Soil (control)	31.3	0.78	0.24	26.30	8.2	2.42	0.76	8.56	2.67
LED_{05}	12.8	-	-	-	-	-	-	-	-
*Average data of three cuts are shown									

Table 2: Content and output of substances determining pharmaco-chemical value of sweet basil in conditions of different hydroponics systems and *soil culture.

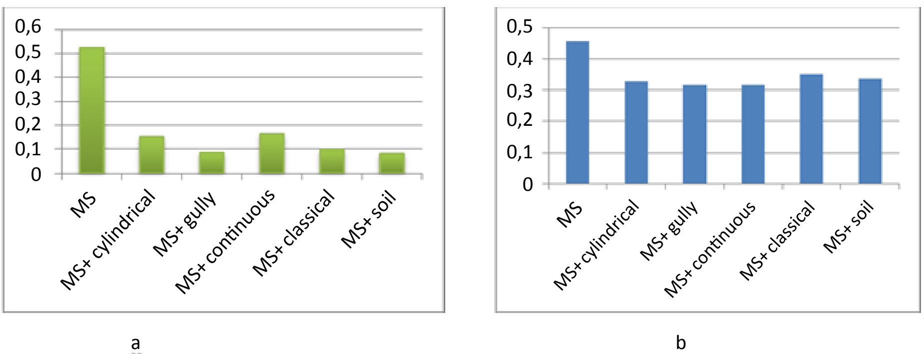

Figure 1: Peppermint (a) and sweet basil (b) antioxidant activity, % in conditions of different hydroponics systems and soil culture.

hydroponics systems and soil culture can be natural sources of antioxidants. Antioxidant activity of 5 mg/ml peppermint was 68% to 84% and in case of 1 mg/ml sweet basil 23% to 31%.

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