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Comparative Description of Essential Oil Quantitative and Qualitative Indexes During the Growth and Development of Sweet Basil in Conditions of the Newest Water-Stream Hydroponics

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Abstract

Sweet basil's raw material grown in the experimental modules of the newest water-stream hydroponics (cylindrical, gully, continuous) and in classical hydroponics exceeds soil culture with dry weight 2.3-4.8 times. The more intensive synthesis of essential oil is observed during the first cut (July) in cylindrical and classical hydroponics and partially in continuous hydroponics and during the second cut (August) in conditions of gully hydroponics and soil culture. Simultaneously during vegetation the maximal output of essential oil (1.3-6.4 times) was provided in cylindrical hydroponics system. High content of the essential oil's most important ingredient methyl chavicol (43%) is observed in cylindrical hydroponics system during July and August cut.

Keywords: Water; Stream hydroponics; Sweet basil; Essential oil; Estragole; Productivity

Introduction

Armenia as a typical mountainous country is not deprived from the phenomena developing desertification and soil salinization, degradation which in its turn has direct or indirect negative impact on the social conditions of the population. The best arable lands of the Republic are occupied by the crops, which large-scale production is a vital necessity. Hence it is more purposeful to use useless rocky, sandy and other territories not proper for conventional farming for production medicinal, spicy and other low-tonnage valuable crops applying for a modern, new and expensive principal, economically productive, high technological methods of plants production which is, undoubtedly, hydroponics or soilless culture [1].

Soilless culture of plants, as a new sphere of biological industry, modern biotechnological method of obtaining raw material, enables optimal conditions for plant growth and development, and through headed conditions to obtain more effective, high quality, ecologically clean raw material [2].

In the Institute of Hydroponics Problems of National Academy of Sciences of the Republic of Armenia, a new hydroponics system is created and chartered by use of polymer membrane which is 'water-stream hydroponics system' with its variety (cylindrical, gully, continuous), which with its law expense and more automated system replenishes the existing well known hydroponics system range [3].

The aim of the observation is to carry out comparative examination on efficiency of valuable essential oil containing and medicinal crop of sweet basil in experimental modules of water-stream hydroponics, classical hydroponics (CH) and soil culture as well as, at the first time, quantitative and qualitative peculiarities of essential oil in raw material.

Materials and Methods

Sweet basil is used as a spicy and medicinal plant. The obtained preparation from leaves and seeds is used for curing atherosclerosis, different etiological tumors, avitaminosis, spasm, digestive tract, cough, bronchial asthma, epilepsy, skin diseases and in case of blood circulation recovery [4]. Essential oil obtained from the plant is recommended to use in case of bronchitis, flue, cold, dizziness, headache, migraine, depression, nervous fatigue, dysbacteriosis, menstrual disorders and hair loss. It has high antibacterial properties and it is also used for curing dental diseases [5-8]. Fresh and dry leaves, flowers, seeds are used in traditional medicine.

Peculiarities and growing biotechnology cultivation experiments of sweet basil have been carried out in the Ararat Valley conditions, which has sunny, dry continental climate, long hot summer with great fluctuation of temperature and humidity. In conditions of water-stream hydroponics the plants have been set in cylindrical, gully, continuous systems and in semi-productive beds of hydroponics experimental station with 8 plant/m^2 surface. Volcanic red slag filler with 3-15 mm diameter particles was used in all hydroponics systems. The plants were nourished with G.S. Davtyan's nutrient solution [9], with 0.5-0.75 concentration during all vegetation period. In water-stream hydroponics the nutrient solution was pushed irretrievably (6-20 times, with 10-15 second duration) in the form of jet to the root-bearing stratum of the plant during the day. One-time given solution is 20-50 ml depending on weather conditions. In classical hydroponics the plants nutrition was 1-3 times, in soil culture once 3-4 days where the all agricultural rules were kept (weed, loosening, fertilization and so on).

The content of essential oil in dry raw medicinal material was determined according to State Pharmacopeia SPh XI [10] and the qualitative analysis of the essential oil was carried out with EM 640S

Variant	Height of the plant, sm	Diameter of base of stem	Dry weight of raw material, g/plant	Dry weight of stem g/ plant	Dry weight of root, g/ plant
Cylindrical	55	15.0	122.6	47.3	24.2
Gully	50	13.7	92.3	43.1	16.7
Continuous	48	14.2	89.5	36.8	15.5
CH	33	13.1	57.2	21.6	7.6
Soil	43	12.0	25.4	13.1	4.6
LED_{05}	--	--	10.8	--	--

Table 1: Biometrical measurements and productivity of sweet basil.

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model modern gas-chromate-mass-spectrometer (GCH-MS) of Bruker Daltonik company, with "HP-5MS" method. Component identity of essential oil is determined by NIST-MS computer library database as well as with the help of comparative samples. The replication of the experiments was 4-8 fold; the mathematical samples were implemented according to Dospexov [11].

Variant	Dry weight of raw material, g/plant	Raw medicinal material dry weight, g/plant		
		I cut July	II cut August	III cut September
Cylindrical	122.6	29.8	57.2	35.6
Gully	92.3	21.5	41.1	29.7
Continuous	89.5	23.8	37.3	28.4
CH	57.2	14.7	25.2	17.3
Soil (control)	25.4	4.7	14.1	6.6
LED_{05}	10.8	--	--	--

Table 2: Yield of sweet basil by cuts in different processing conditions.

Variants	Essential oil content by cuts, (%)			Essential oils*		Humidity*
	I cut	II cut	III cut	%	output, g/plant	%
Cylindrical	0.92	0.82	0.75	0.83	1.02	9.49
Gully	0.73	0.91	0.88	0.84	0.77	8.77
Continuous	0.74	0.73	0.55	0.67	0.60	9.42
CH	0.82	0.73	0.55	0.70	0.40	9.20
Soil (control)	0.55	0.75	0.57	0.62	0.16	10.31

*Average data of 3 cuts

Table 3: Phama-chemical rates of sweet basil.

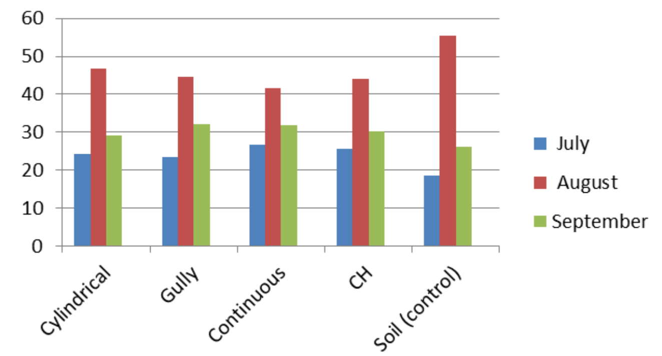

Figure 1: Dry weight of raw medicinal material by cuts (%).

Results and Discussion

Sweet basil raw material, grown in cylindrical and classical hydroponics, with dry weight exceeds soil culture 2.3-4.8 times (Table 1). At the same time advantages of cylindrical hydroponics is observed compared to other hydroponics systems, which contributed to the basil dry raw material increase 1.3-2.1 times. Cultivation conditions effect on the development of sweet basil root system is quite substantial again. It can be concluded that it is observed increase of root mass weight nearly 1.4-5.3 times in the sample which provides maximum raw medicinal material (Table 1).

From the analyses of Table 2 is clear that grow intensity of sweet basil from July to September is changed regardless cultivation conditions: high quality crop was produced during the second harvest in August (nearly 42% to 56%) and raw material exceeded the cuts of previous months 1.3-3.0 times.

According to the obtained data (Table 3 and Figure 1) in cylindrical and classical hydroponics, and partially in continuous, essential oil synthesis was the most intensive during the first cut in raw medicinal material, but in gully hydroponics and soil culture conditions during the second cut. It should be mentioned that among the tested systems due to high productivity of basil cylindrical hydroponics system provided maximum output (1.3-6.4 times) of essential oil per plant during vegetation.

According to the literary data chemical composition of the essential oil of sweet basil is rather complex: the main components are estragole (40% to 52%) and linalool (20%) which give the plant anti-inflammatory, antiviral properties and fresh, delicate citrus taste. The obtained results from the fulfilled investigations in water-stream, classical hydroponics and soil culture conditions has shown (Table 4) that in experimental variants quantitative indices of essential oil vary considerably. Overall high content (43%) of extragol has been observed in cylindrical hydroponics conditions. In this case the above mentioned

N	The main ingredients of essential oil	Cylindrical		Gully		Continuous		Classical		Soil	
		Registration time, minutes	Content, %	Registration time, minutes	Content, %	Registration time, minutes	Content, %	Registration time, minutes	Content, %	Registration time, minutes	Content%
1	β-myrcene	9.30	0.26	9.27	0.28	9.33	0.18	9.32	0.6	9.30	0.13
2	Cineol	10.29	3.67	10.25	3.94	10.30	3.62	10.30	4.15	10.28	3.14
3	Fenchone	---	---	11.58	0.21	18.71	0.9	18.71	2.72	18.67	1.73
4	Linalool	11.86	41.25	11.87	40.10	11.88	27.22	11.90	46.3	11.91	40.2
5	Camphor	12.91	0.85	12.87	0.7	12.92	0.80	12.92	0.8	12.90	0.66
6	Borneol	13.36	0.21	13.32	0.032	13.37	0.51	13.36	0.5	13.35	0.37
7	Terpineol	13.87	0.57	13.85	0.57	13.89	0.45	13.89	0.6	13.88	0.6
8	Estragole	14.05	42.72	14.03	27.1	14.06	26.84	14.06	28.92	14.06	23.9
9	Eugenol	16.52	0.36	17.17	1.3	16.48	0.51	17.22	0.94	17.19	1.43
10	Elemene	17.92	0.99	17.88	1.3	17.93	1.0	17.93	1.33	17.89	1.63
11	Caryophyllene	18.49	0.47	15.45	0.55	---	---	18.50	0.9	18.46	0.64
12	a-Bergamotene	18.70	1.66	18.66	3	---	---	19.28	0.3	---	---
13	Humulene	19.27	0.21	19.08	0.9	19.13	0.14	19.13	0.63	19.09	0.75
14	Germacrene	19.70	0.64	19.56	1.95	19.70	0.85	19.61	0.72	19.57	1.98
15	Azulene	20.01	0.46	18.75	0.23	---	---	20.01	0.72	19.98	0.92
16	Naphthalene	19.60	0.86	20.12	2.1	20.16	1.3	20.16	2.06	---	---
17	Cubenol	21.92	0.37	21.85	0.18	21.90	0.41	21.90	0.60	21.86	0.9
18	Cadinol	22.58	0.39	22.27	6.55	22.30	3.30	22.30	5.81	22.28	6.55

Table 4: Chemical description of the essential oil of sweet basil in conditions of hydroponics and soil culture.

N	Indexes	I –cut			II -cut			III- cut		
		Minutes	F	%	Minutes	F	%	Minutes	F	%
1	β-myrcene	9.27	952	0.25	9.30	936	0.26	9.31	967	0.26
2	Cineol	10.25	930	3.8	10.29	930	3.67	10.29	925	3.34
3	Fenchone	11.59	894	0.38	---	--	---	--	--	--
4	Linalool	11.80	929	38.1	11.86	951	41.25	11.88	959	38.21
5	Camphor	12.87	958	0.92	12.91	978	0.85	12.91	984	1.62
6	Borneol	13.29	894	0.33	13.36	825	0.21	---	---	---
7	Terpineol	13.83	964	0.49	13.87	951	0.57	13.88	943	0.56
8	Estragole	13.99	990	42.36	14.05	994	42.72	14.06	994	36.78
9	Eugenol	16.49	982	0.54	16.52	967	0.36	17.21	977	0.4
10	Elemene	17.88	972	0.92	17.92	985	0.99	17.92	983	1.08
11	Caryophyllene	18.46	939	0.40	18.49	967	0.47	18.51	972	0.43
12	α-Bergamotene	18.67	977	1.79	18.70	977	1.66	18.71	966	1.28
13	Humulene	19.08	967	0.47	19.27	970	0.21	19.14	988	0.51
14	Germacrene	19.68	987	0.74	19.70	981	0.64	19.64	977	1.58
15	Azulene	19.98	924	0.48	20.01	963	0.46	18.80	982	0.31
16	Naphthalene	20.12	965	0.14	19.60	963	0.86	---	---	---
17	Cubenol	21.86	865	0.25	21.92	844	0.37	22.01	876	0.4
18	Cadinol	22.50	967	0.39	22.58	961	0.38	22.96	959	0.6

Table 5: Qualitative structure of the essential oil of sweet basil in cylindrical hydroponics system.

material content compared to the other variants on average increases 1.5-1.8 times. Continuous variant has been marked by low linalool content, meanwhile in cylindrical, gully, classical hydroponics and soil culture it is amounted to 40% to 60%. Low content of cineol; it should be mentioned it is used for curing caught, muscle pain, neurosis, asthma, it has antioxidant influence; has been observed in plants grown by soil culture (3.14%), and low content of cadinol in cylindrical hydroponics system (0.39%).

As it is mentioned above essential oil has certain chemical structure during each vegetation period. From the carried out results it turned out (Table 5) that in cylindrical hydroponics system high content of extragol was observed during the I and II cut (nearly 43%) and linalool high content was observed in August (41%). Significant difference was not observed during the cuts in percentage contents of β-myrcene, cineol, caryophyllene and partially in terpineol. Based on the results of (Table 5) at the end of vegetation the amount of camphor, germacrene, cadinol increases. It is necessary to mention essential oil fenchone component is found out only during the 1 cut in cylindrical hydroponics.

Conclusion

Raw material of sweet basil obtained by different hydroponics methods with dry weight exceeds soil culture 2.3-4.8 times. Simultaneously cylindrical hydroponics compared to the other hydroponics systems contributed to the increase of raw material dry weight 1.3-2.1 times. Synthesis of essential oil was more intensive during the first cut, but in gully hydroponics and soil culture conditions during the second cut. Cylindrical hydroponics system provided maximum output (1.3-1.6 times) of essential oil during vegetation.

High content of estragole in essential oil (43%) was registered in cylindrical hydroponics system and law content of linalool (27%) in continuous system. High content of estragole was observed in July and August during the vegetation period in cylindrical hydroponics system, and high content of linalool was observed in August (41%).

Till today there is no relevant data on basil raw medical material in the State Pharmacopoeia. The obtained results, probably, will help to create such a scientific and technological document.

References

1. Davtyan GS (1980) Hydroponics: Reference book on chemicalization of agriculture. M Kolos: p: 382-385.
2. Davtyan GS (1969) Hydroponics as a production achievement of agrochemical sciences. XVIII Scientific readings dedicated to the memory of Academician Pryanishnikov D.N., Ed. AN Arm. SSR, p: 85.
3. Dospechov BA (1985) Field experiment method. Moscow p: 223-228.
4. Dunn P (2012) An aquaponics experiment where tilapia and tomatoes can be best buddies. Times-News, The (Twin Falls, ID) 12 Dec. 2012: Newspaper Source Plus. Web 24-Jan. 2013.
5. Mayrapetyan SKH (2007) Davtyan Institute of Hydroponics. Problems NAS RA in 60 years. Reports of IHP NAS RA, No.3. p: 3-16 .
6. Mairapetyan SKH, Daryadar MKH, Alexanyan JS, Tadevosyan AH, Tovmasyan AH, et al. (2013) Comparative description of productivity and content of biologically active substances of some essential oil-bearing plants in conditions of new water stream hydroponics. Biological Journal of Armenia 3: 80-84.
7. Mairapetyan SKH, Tadevosyan AH, Hovsepyan AH, Mairapetyan KHS (2006) Method of soilless cultivation of plants and their implementation system. Invention Patent of Ra, No.1849 A2.
8. Mayrapetyan SKH, Tadevosyan AH, Hovsepyan AH, Mayrapetyan KhS (2007a) Method of soilless cultivation of planted crops and their implementation system. Invention Patent of Ra, No.1946 A2.
9. Mayrapetyan SKH, Tadevosyan AH, Hovsepyan AH, Mayrapetyan KhS (2007b) Method of soilless cultivation of sowed herbs and their implementation system. Invention Patent of Ra, No.1988 A2.
10. Mayrapetyan SKH, Tadevosyan AH, Hovsepyan AH, Mayrapetyan KhS (2007c) Method of soilless cultivation of herbs and their implementation system. Invention Patent of Ra, No.1989 A2.
11. Özcan M, Chalchat C (2002) Essential oil composition of *Ocimum basilicum* L. and *Ocimum minimum* L. in Turkey. Czech J Food Sci 20: 223-228.