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Original Article

Effects of Various Drying Methods on the Quantity and Quality of Peppermint (*Mentha piperita* L.) Essential Oil

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Abstract

Background and Aim: The quality of medicinal plants could be affected by different factors such as drying methods. Peppermint (*Mentha piperita* L.), which is native to the Mediterranean region, is cultivated for food, pharmaceutical and perfumery uses throughout the world. The aerial part of peppermint contains essential oil, phenolic and flavonoid compounds, fatty acids, vitamins, minerals, and salicylic acid.

Materials and Methods: The impact of the drying process on the essential oil of peppermint was evaluated in an experiment with a much-randomized design using four treatments (oven drying at 40 and 50ºC, shade and semi-shade drying) and three replications. The measured parameters included dry weight and oil quality as well as quantity.

Results: According to the results, different drying methods had remarkable impacts on the investigated parameters at P<1%. The results indicated that the highest dry weight and essential oil content were obtained from the semi-shade drying method. While drying at 50ºC showed the maximum total menthol, the maximum p-Menthone, dl-Limonene, and Pulegone, Piperitone were obtained from the shade-drying method, and the maximum alpha-pinene, Sabinene, Menthofuran,1,8-Cineole, and trans-Caryophyllene were related to the shade-drying method, and the maximum β-pinene, menthyl acetate, and neo-Menthol were obtained from drying at 40ºC.

Conclusion: Overall, the results of the present experiment showed that the highest amounts of essential oil contents were obtained from shade and half-shade methods.

Keywords: Peppermint, Drying, Shade drying, Semi shade drying, Essential oil.

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Introduction

Peppermint (*Mentha piperita* L.) is considered as one of the most significant medicinal herbs whose essential oils are extensively used in pharmaceutical, food, cosmetic, and hygienic products. This plant, which is categorized as a member of Lamiales and the Lamiaceae family, is a cross between the species *M. aquatic* and *M. spicata* (1).

The peppermint essential oil and its constituents are used in pharmaceutical, food, cosmetic, pastry, soft drink, and spice industries. The medicinal properties

of peppermint essential oil have been well proven by most pharmacopoeias. Peppermint and its essential oil are used in the treatment of decreased appetite, common cold, cough, fever, nausea, headache, inflammatory bowel disease (2), spasm, gas, and indigestion (3). Moreover, antibacterial (4), antiviral, antitumoral and antiallergic properties have been reported for this plant (5). The production of essential oil in medicinal and aromatic plants is affected by environmental factors and genetic control.

Peppermint essential oil is comprised of over 20 constituents, including tens or hundreds of volatile and nonvolatile compounds that are responsible for its aroma and taste (6). Drying is among the oldest preservation methods for agricultural products, and is an important post-harvest stage handling that plays a significant role in the quantity and quality of their active ingredients. In fact, this method is used to preserve the quality of medicinal plants such as peppermint (7). Various medicinal parts of plants, including leaves, stems, flowers, seeds, etc., have high moisture contents of 60-80% when newly harvested. This moisture level makes the product susceptible to the invasion of fungi and other microorganisms resulting in harmful biochemical reactions (7). For this reason, it is impossible to preserve the medicinal parts of these plants with high moisture content, even for a short time. Hence, the moisture level of medicinal plants should decrease by 10-14%. This decrease in moisture has a positive impact on the quantity and quality of essential oils of medicinal plants (7).

The drying process has a noticeable effect on the percentage and constituents of essential oil, and this effect varies with the drying temperature and duration as well as plant species (8). The results of a study indicated that drying peppermint at 35°C could reduce the quantity and quality of its essential oil (9). Solar drying of peppermint, English lavender, rosemary, thymes, and Dracocephalum showed that the essential oils of these plants were decreased by 24% under the sun; whereas with shade drying the decrease was only 1 to 2% (10). In a study, the effects of the temperatures 30 and 70°C were investigated on the components of meadowsweet (*Filipendula ulmaria*) and willow (*Salix alba*) essential oils. The results showed that the temperature 70°C could shorten drying duration, and at once decreased flavonoids and increased tannins (11). The results of drying rosemary at 60°C showed that this temperature could bring about a significant reduction in the quality and amount of its essential oil (12). It has been indicated that, by drying peppermint in 500-watt microwaves, the essential oil content was minimized, but its color was maintained during the process of plant drying (13).

Since the amount and constituents of essential oils are highly influenced by the drying method, it is necessary to consider a proper method for drying (14). Therefore, the present study aimed to find the optimum method to maximize the quantity and quality of the essential oil extracted from the peppermint samples.

Materials and Methods

In order to examine the effect of distinct drying methods on the quantity and quality of the essential oil of peppermint (*Mentha piperita* L.), the aerial parts of the plant were gathered from a farm in the vicinity of Zanjan at 09:00-11:00 in the first half of Sep, 2016 (the second harvest of the plant). Immediately, the peppermints were transferred to the medicinal plant laboratory of the University of Zanjan. Subsequently, 300-g samples of fresh peppermint were dried (each with three replications) at 40 and 50°C by a Heraues oven (Heraues T6060, Germany, with the dimensions of 740×670×580mm, 1.5kW, 240V, 6.8A). The samples were placed at 40°C for 28 hours and at 50°C for 20 hours to dry thoroughly. Then, their dry weights were measured. After that, other 300-gram peppermint samples were dried in shade (in three replications) at 25°C for 108 hours in closed spaces devoid of direct light (with the light intensity of 402 lux). Subsequently, they were exposed to air circulation, and at one they were denied the exposure to any scented or aromatic materials. Their dry weights were measured afterward. Then, other 300-gram fresh peppermint samples were placed in a chamber covered with a plastic cover in a dry place outside the building under a clear and sunny sky. The outside and inside temperatures of the chamber were 24 and 25°C respectively, and the environment light intensity was 1159 lux. They were dried for 96 hours. Then, their

dry weights were measured. Essential oils were extracted by water distillation method using a Clevenger apparatus by the ratio of plant dry matter to water 1 to 10 for 3 hours in exactly the same conditions for all treatments.

Gas chromatograph- Mass spectrometer Conditions

In order to identify the constituents of the essential oil, a gas chromatograph coupled to a mass spectrometer (GC/MS) was used with certain requirements as follows. An Agilent (US) 7890A gas chromatograph was utilized. The capillary column had HP-5MS of 30 m in length and 0.25 mm diameter, and the stationary phase thickness was 0.25 µm. The initial temperature was 60ºC with 4ºC for minutes up to 270ºC. The gas contained 99.999% helium and a flow rate of 1 mL/min.

The variance analysis of the data collected from the first experiment conducted as a totally randomized design with 4 treatments and 3 replications was performed by the SAS software package, version 9.4, and the means comparison was performed by Duncan's multiple range method at 1% level.

Results and Discussion

According to Table 1, the peppermint essential oil constituents were identified for different drying methods. The most important constituents were menthol, p-menthane, piperitone, menthofuran, pulegone and menthyl acetate, pinene, 1,8-cineole, and dl-limonene. In what follows, their changes under different treatments are described.

Menthol: The highest amount of menthol was obtained from the method of drying at 50ºC (50.60%), whereas the lowest level was derived from the half-shade (39.41%) according to Table 1.

P-menthane: According to Table 1, the highest amount of menthane was related to the shade-drying method (7.78%), while the lowest amount belonged to the half-shade drying method (4.45%).

Piperitone: According to Table 1, piperitone amount was 0.51% for the method of drying at 40ºC and 0.6% for the shade.

Menthofuran: The highest amounts of menthofuran were also observed in the methods of drying in shade (6.55%) and half-shade (6.58%) (Table 1).

Pulegone: The amount of this compound was 0.29% for the method of drying at 40ºC and 0.47% for the shade (Table 1).

Menthyl acetate: The highest amount of this compound was also observed in drying at 40ºC (20.59%) and shade (19.96%), respectively (Table 1).

Pinene: For the α-pinene type, the highest amounts were observed in the method of drying in half-shade (0.64%) and shade (0.44%), at 40ºC (0.43%), at 50ºC (0.34%), and also, for the β-pinene type, the highest among the drying methods were related to half-shade (0.8%) and shade (0.58%) respectively (Table 1).

Sabinene: The highest amount of this compound was for the drying method in half-shade (0.45%) (Table 1).

1,8-cineole: The highest amount of this compound was also observed in the half-shade drying method (6.8%) and the lowest amount in shading at 50ºC (1.96%) (Table 1).

Dl-limonene: The highest amount of limonene was obtained in the method of drying in shade (1.2%) (Table 1).

According to the results of the variance analysis (Table 2), drying methods had significant effects ($P < 0.01$) on the dry weight, essential oil weight and the essential oil percentage of the peppermint plants. The results of the means comparison showed that the highest dry weight, essential oil weight, and the essential oil percentage were obtained from the half-shade drying method (Table 3).

Overall, the results of this experiment showed that the shade and half-shade methods were superior, and the highest essential oil weight was derived from the half-shade method, followed by the shade method. In fact, with the increase in the drying temperature, the amounts of essential oil constituents decrease due to the increase in the transfer rate of water molecules to the surface of medicinal plants and the increase in the transfer rate of aromatic composition molecules in the process of evaporation (15). The results of a study on feverfew revealed that with the increase in temperature in the drying process, parthenolide content of the plants decreased [16]. Omidbaigi *et al*. (17) reported the highest amount of Roman chamomile essential oil for shade drying. It has been reported that the temperatures of 50 and 70ºC reduced essential oil contents significantly, but 30ºC was the most appropriate temperature for increasing the amount and constituents of the essential oil (18). Asekun *et al*. (15)

observed that oven-drying at 40ºC caused the main compound of pennyroyal plant (menthone, 1,8-cineole and pulegone) to evaporate and change. They suggested that this plant

Table 1: The chromatogram of essential oil analysis.

Code	Component	KI	50 ºC	40 ºC	shade	Semi shade
1	α-Pinene	934	0.34	0.43	0.44	0.64
2	Sabinene	974	0.17	0.23	0.30	0.45
3	2-β -Pinene	980	–	–	0.58	0.80
4	β-pinene	981	–	0.53	–	–
5	β-Myrcene	994	–	0.07	0.10	0.16
6	3-Octanol	995	0.16	0.10	0.09	0.14
7	dl-Limonene	1028	0.64	0.76	1.20	–
8	Cymene	1029	–	0.14	0.11	0.18
9	1,8-Cineole	1031	1.96	2.28	2.00	6.80
10	cis-Ocimene	1043	–	–	0.08	–
11	trans-beta-Ocimen	1050	–	–	–	0.16
12	α-Terpinene	1057	–	0.06	–	0.14
13	γ-Terpinene	1060	–	0.14	0.18	0.30
14	cis-sabinenehydrate	1070	0.86	0.99	1.25	1.24
15	α-terpinolene	1096	–	0.06	0.07	0.10
16	Linalool-L	1097	–	–	–	0.14
17	Iso-amylisovalerate	1106	–	–	0.12	–
18	n-Amyl isovalerat	1107	–	–	–	0.11
19	p-menth-2-en-1-ol	1108	–	–	–	0.06
20	Isopulegol	1134	–	–	0.08	0.06
21	p-Menthone	1137	5.88	7.64	7.78	4.45
22	menthofouran	1164	–	–	6.55	6.58
23	neo-Menthol	1166	7.62	8.73	5.84	4.99
24	Menthol	1172	50.60	48.73	46.20	39.41
25	Pulegone	1208	–	0.29	0.47	–
26	p-Menth-4(8)-en-3-one	1244	–	–	–	0.52
27	3-Cyclohexen-1-one 2-isopropyl-5-methyl	1251	0.48	–	–	-
28	Piperitone	1253	–	0.51	0.60	–
29	Menth-1-en-3-one	1259	–	–	–	0.63
30	Neo menthol acetate	1273	–	–	1. 12	–
31	Iso menthyl acetate	1282	–	1.19	–	–
32	Carane	1287	–	–	–	1.81
33	Neo iso menthyl acetate	1289	1.22	–	1.00	–
34	Camphane 1	1291	24.45	–	–	–
35	menthyl acetate	1295	–	20.59	19.96	–
36	Camphane	1299	–	–	–	23.45
37	p-Menth-3-ene	1321	1.09	–	–	–
38	cis-Carane	1357	–	1.02	–	–
39	p-Menth-8-en-2-ol	1368	–	–	0.08	–
40	β.bourbonene	1374	0.25	0.32	0.37	0.47
41	trans-Caryophyllene	1396	0.83	0.73	0.99	1.52

42	alpha-Humulene	1417	–	–	–	0.08
43	beta-farnesene	1446	–	–	–	0.22
44	trans-.beta.-Farnesene	1454	–	0.18	–	0.26
45	Germacrene-D	1485	1.04	0.86	1.30	1.51
46	Mintfuranone2	1491	–	0.21	–	–
47	bicyclogermacrene	1497	–	–	–	0.22
48	delta-Cadinene	1530	–	–	–	0.05
49	spathulenol	1555	–	–	–	0.15
50	Caryophyllene oxide	1572	–	0.21	–	0.22
51	γ-Gurjunene	1586	1.23	–	–	–
52	veridiflorol	1593	–	–	–	0.81
53	Germacrene B	1669	–	0.18	–	–
54	1-Octadecanol	1773	–	0.06	–	–
55	neophytadiene	1810	0.45	–	–	–
-	Total Compounds	–	99.27	97.44	97.24	98.83

Table 2: Analysis of variance for the effect of different drying methods on dry weight (g), weight of essential oil (g) and percentage of essential oil.

		Means of squares		
S.O.V	**d.f**	**dry weight**	**weight of essential oil**	**percentage of essential oil**
Drying method	3	2195.88**	0.809**	0.328**
Error	8	78	0.018	0.008
C.V %	-	9.28	15.08	10.75

**: Significant at 0.01 probability level
S.O.V: Sources of variation
d.f : degrees of freedom

Table 3: Mean comparison for the effect of different drying methods on dry weight (g), weight of essential oil (g) and percentage of essential oil

drying method	percentage of essential oil	weight of essential oil	dry weight
40°C	0.58 b	0.49b	81.667b
50°C	0.54 b	0.41 b	65.000 b
shade	1.12 a	1.22a	108.333a
Semi-shade	1.15 a	1.44a	125.333a

Means followed by the same letter(s) are not significantly different at 0.05 level of probability.

should be oven-dried at 40°C because an excessive increase in the menthone and pulegone contents of this plant would result in injuries to the liver. Hence, it should be taken into account which constituents of the essential oil of a medicinal plant under consideration are required by the pharmaceutical industry. For *satureja* plants as well, the results showed that the highest amount of the essential oil was obtained from the shade drying method (19). Moreover, it has been observed that drying in half shade has the highest essential oil content following the shade method. Thus, the shade-drying method is of greater significance than the methods of drying at 40 or 50°C.

Conclusion

Drying is a process which determines the quality of medicinal plants and consequently, their economic values due to its effect on the amounts of active

ingredients and the contents of their constituents. The highest amounts of essential oil contents were obtained, in descending order, for the half-shade and shade-drying methods. Furthermore, in addition to the essential oil quantity, the highest quality of peppermint essential oil should be taken into account considering the constituents required by the pharmaceutical, food and cosmetic industries and the drying method should be chosen based on the goal. The highest menthol content, for instance, is obtained from, in descending order, drying at 50ºC (50.6%) and 40ºC (48.73%), but the dried plant has the lowest amount of essential oil.

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None.

Conflict of Interest

The authors declare that they have no conflict of interest.

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