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Fragrance Chemicals in the Essential Oil of *Mentha arvensis* Reduce Levels of Mental Stress

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The aim of this work was to determine the chemical composition of essential oil from aerial partsof *Mentha arvensis* L. f. *piperascens* (MAO) and to evaluate the effect of its fragrant chemicals on electroencephalographic (EEG) activity of human brain. The MAO was obtained by supercritical CO_2 extraction. The maximum yield was 2.38% at conditions of 70ºC and 200 bar. There were 32 volatile chemicals with 6 alcohols (67.11%), 13 hydrocarbons (17.05%), 9 esters (11.50%), 2 ketones (7.16%), 1 oxide (2.77%), and 1 aldehyde (0.56%). The major components were (*Z,Z,Z*)-9,12,15-octadecatrien-1-ol (50.06%), 2-hydroxy-4-methoxyacetophenone (7.50%), and 3,4-dihydro-8-hydroxy-3-methyl-1H-2-benzopyran-1-one (6.60%). Results of the EEG study showed that inhalation of MAO significantly changed the EEG power spectrum values of relative gamma, relative fast alpha, and spectral edge frequency 90%. During the inhalation of MAO, the value of relative fast alpha was significantly increased ($p<0.05$). On the other hand, the values of gamma and the spectral edge frequency 90% were significantly decreased ($p<0.05$). The present study suggests that fragrant chemicals of essential oil of *M. arvensis* reduce the level of mental stress and that they could be used in the treatment of psychophysiological disorders.

Key words : Electroencephalogram, *Mentha arvensis*, essential oil, fragrance, supercritical extraction

Introduction

The genus *Mentha* (Lamiaceae syn. Labiatae) comprises approximately 30 species and members of this genus are characterized by their volatile oils which are of great economic importance, being used by the flavor, fragrance and pharmaceutical industries [7, 21]. *Mentha arvensis* L. f. *piperascens* Malinvaud *ex* Holmes is commonly cultivated in tropical and sub-tropical climates. The plant is aromatic, stimulant and carminative, and it has been used as antispasmodic, anti-mycotic and anti-peptic ulcer agents [13, 23]. It contains several aromatic and bioactive compounds such as menthone, menthofuran, sesquiterpenes, flavonoids, triterpenes, carotenoids, tannins and minerals [16]. It has unique importance among the species because of its high content of (1*R*,2*S*,5*R*)-2-isopropyl-5-methylcyclohexanol (menthol). Due to physiological cooling effects of menthol, the plant has been used as fragrance component in soaps, detergents, cosmetics, confectionary and toothpastes [1, 22].

The pharmaceutical properties of aromatic plants are commonly attributed to its essential oils. Essential oils are complex, multi-component systems mainly composed of terpenes [8]. They are one of the important sources for the treatments of various psychophysiological disorders such as depression, anxiety and cognitive disorders [18]. The physiological and psychological effects of fragrances could be evaluated by electroencephalographic (EEG) study. Taking into account the popular uses and biological activities of *M. arvensis*, it is surprising that no psychophysiological study has been performed concerning the effect of its essential oil on EEG activity of human brain. Therefore, the present investigation was undertaken to determine the chemical composition of essential oil from aerial parts of *M. arvensis* using GC/MS analysis and to evaluate the effect of its inhalation on EEG activity of human brain.

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Materials and Methods

Plant material

Aerial parts of *Mentha arvensis* L. f. *piperascens* were purchased from BN Herb Inc., Pyeongchang, South Korea. A voucher specimen was deposited in the Herbarium of Kangwon National University under the number KWNU 85135. The plant material was dried at room temperature, ground to a powder using a blender and stored at -20°C prior to use.

Supercritical CO_2 extraction (SFE)

The SFE of essential oil from aerial parts of *M. arvensis* (MAO) was performed on an ISA-SCCO-S-050-500 SFE device (ILSHIN Autoclave Co. Ltd., Daejeon, Korea). Carbon dioxide (99.5%, w/w pure) was delivered from a standard cylinder and compressed to an extraction pressure by an air-driven liquid pump. For each condition, about 120 g of milled *M. arvensis* aerial parts were loaded into a stainless steel extraction vessel. During the extraction process, the extraction pressure, extraction temperature and CO_2 flow rate were controlled by adjusting the regulating valves. To optimize the SFE conditions for MAO, the extraction was conducted at different pressures (200, 300 and 400 bar) and temperatures (40, 50, 60 and 70°C). The CO_2 flow rate was maintained at 30 ml/min. After one hour of extraction time, the extraction vessel was depressurized and the oil was collected from the separation vessel. The amount of extracted oil was determined gravimetrically after collection, and the extraction yield was expressed as percent of the dry weight of aerial parts of *M. arvensis*.

Gas chromatography/mass spectrometry (GC/MS) analysis

GC/MS analysis of MAO was performed using a Varians CP3800/Varians 1200L gas chromatography/mass spectrometer, equipped with a Varians VF-5MS polydimethylsiloxane capillary column (30 m × 0.25 mm, film thickness 0.25 μm). The oven temperature was initially at 50°C (held for 5 min) and then increased to 250°C at 5°C/min. The injector temperature was maintained at 250°C. The ion source temperature was 280°C and electron energy was 70 eV. The analyzer was scanned over the range of m/z 50 to 500. Helium gas was used as a carrier gas at a constant flow rate of 1 ml/min. The components of MAO were identi fied on the basis of comparison of their retention times and mass spectra with publish data and computer matching with Wiley 275 and National Institute of Standards and Technology (NIST, 3.0) spectral libraries.

Effect of inhalation of MAO on EEG activity

Subjects

Twenty right-handed healthy volunteers (10 men and 10 women) aged 20-30 years participated in this study. None of the subjects had olfactory diseases, smoked or abused drugs. All subjects gave their informed consent before participation.

EEG recordings

EEGs were recorded using QEEG-8 system (LXE3208, LAXTHA Inc., Daejeon, Korea) from 8 grounding electrodes placed on the scalp at left prefrontal (Fp1), right prefrontal (Fp2), left frontal (F3), right frontal (F4), left temporal (T3), right temporal (T4), left parietal (P3) and right parietal (P4) according to the International 10-20 System. All electrodes were referenced to the ipsilateral earlobe electrode.

Fragrance Administration

MAO was used as the fragrance stimulus. The stimulus was presented to the subjects in a randomized sequence. EEG measurement sites maintain a constant temperature (23°C) and humidity (50%) to 32.5 m^2 size of the laboratory. The subjects were instructed to sit quietly, close their eyes and to breathe normally during the measurement. The fragrance stimulus was dipped in a filter paper (1 cm^2) then placed about 3 cm in front of the subject's nose. EEG was recorded before and during the fragrance exposure for 30 seconds.

Data Analysis

The mean power values [microvolt (μV)] were calculated for 25 EEG analysis indicators (Table 1). The t-mapping of EEG waves of brain was constructed by using Telescan software package (LXSMD61, LAXTHA Inc., Daejeon, Korea). The SPSS statistical package 18 (SPSS, Inc., Chicago, IL, USA) was used for data analysis on EEG activity before and during the exposure of MAO by a paired t-test based on the EEG power spectrum values.

Results

Yield of essential oil

SFE of the essential oil from aerial parts of *M. arvensis* was carried out under different conditions of temperature (40, 50, 60 and 70°C) and pressure (200, 300 and 400 bar),

Table 1. EEG indicators used in the analysis

S. No.	Analysis indicators	The full name of the EEG power spectrum indicators	Wavelength range (Hz)
1	AT	Absolute theta	4~8
2	AA	Absolute alpha	8~13
3	AB	Absolute beta	13~30
4	AG	Absolute gamma	30~50
5	AFA	Absolute slow alpha	8~11
6	ASA	Absolute fast alpha	11~13
7	ALB	Absolute low beta	12~15
8	AMB	Absolute mid beta	15~20
9	AHB	Absolute high beta	20~30
10	RT	Relative theta	(4~8) / (4~50)
11	RA	Relative alpha	(8~13) / (4~50)
12	RB	Relative beta	(13~30) / (4~50)
13	RG	Relative gamma	(30~50) / (4~50)
14	RFA	Relative slow alpha	(8~11) / (4~50)
15	RSA	Relative fast alpha	(11~13) / (4~50)
16	RLB	Relative low beta	(12~15) / (4~50)
17	RMB	Relative mid beta	(15~20) / (4~50)
18	RHB	Relative high beta	(20~30) / (4~50)
19	RST	Ratio of SMR to theta	(12~15) / (4~8)
20	RMT	Ratio of mid beta to theta	(15~20) / (4~8)
21	RSMT	Ratio of SMR~mid beta to theta	(12~20) / (4~8)
22	RAHB	Ratio of alpha to high beta	(8~13) / (20~30)
23	SEF50	Spectral edge frequency 50%	4~50
24	SEF60	Spectral edge frequency 90%	4~50
25	ASEF	Spectral edge frequency 50% of alpha	8~13

in order to evaluate their influence on the yield of the essential oil (Fig. 1). The influence of four different temperatures on the essential oil isolated from *M. arvensis* aerial parts was studied using a constant pressure of 400 bar. The results indicated that the significant increase of essential oil yield with increase of temperature from 40°C (0.28%) to 50°C (1.33%) and the yield was nearly same when increase the temperature from 50°C (1.33%) to 60°C (1.35%). However, the yield was increased with further increment of temperature from 60°C (1.35%) to 70°C (1.64%) at 400 bar pressure. The influence of pressure was studied using a constant temperature at 70°C based on the higher yield. The yield was increased while decreasing the pressure from 400 to 200 bar (1.63% to 2.38%). The optimized extraction conditions for the yield of essential are temperature at 70°C and pressure at 200 bar.

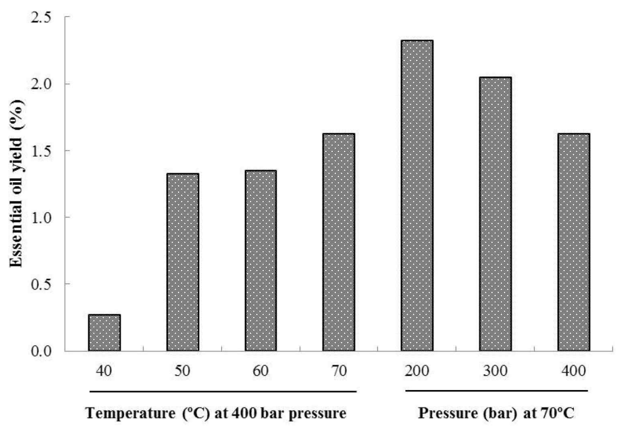

Fig. 1. Yields of essential oil from aerial parts of *M. arvensis* at different supercritical CO_2 extraction conditions. Aerial parts of *M. arvensis* from five different lots were pooled together and used for SFE.

Chemical composition of the essential oil

The identified compounds of the MAO were listed in Table 2 according to their area percentage. Results showed that among 32 components identified, (*Z,Z,Z*)-9,12,15-octadecatrien-1-ol (50.06%) was found to be major compound in the essential oil of aerial parts of *M. arvensis*. In addition, 2-hydroxy-4-methoxyacetophenone (7.50%), 3,4-dihydro-8-hydroxy-3-methyl-1H-2-benzopyran-1-one (6.60%), β-selinene (5.55%), (*Z*)6,(*Z*)9-pentadecadien-1-ol (3.32%), caryophyllene oxide (2.77%), α-selinene (2.76%) and phenylethyl alcohol (1.88%) were found to be considerable levels in the essential oil of *M. arvensis* aerial parts in the present study.

Table 2. Essential oil composition of aerial parts of *M. arvensis*

No.	Retention time (min)	Compound name	Area (%)	Component	CAS number	Formula	M.W
1	40.237	(Z,Z,Z)-9,12,15-Octadecatrien-1-ol	50.06	Alcohol	506-44-5	$C_{18}H_{32}O$	264.45
2	33.738	2-Hydroxy-4-methoxyacetophenone	7.50	Ether	552-41-0	$C_9H_{10}O_3$	166.17
3	36.940	3,4-dihydro-8-hydroxy-3-methyl-1H-2-benzopyran-1-one	6.60	Ketone	17397-85-2	$C_{10}H_{10}O_3$	178.18
4	35.151	β-Selinene	5.55	Hydrocarbon	17066-67-0	$C_{15}H_{24}$	204.35
5	40.106	(Z)6,(Z)9-Pentadecadien-1-ol	3.32	Alcohol	77899-11-7	$C_{15}H_{28}O$	224.38
6	38.008	Caryophyllene oxide	2.77	Oxide	1139-30-6	$C_{15}H_{24}O$	220.35
7	35.376	α-Selinene	2.76	Hydrocarbon	473-13-2	$C_{15}H_{24}$	204.35
8	21.667	Phenylethyl Alcohol	1.88	Alcohol	60-12-08	$C_8H_{10}O$	122.16
9	31.920	β-Elemene	1.59	Hydrocarbon	515-13-9	$C_{15}H_{24}$	204.35
10	34.851	α-Curcumene	1.58	Hydrocarbon	644-30-4	$C_{15}H_{22}$	202.34
11	49.784	Mercaptoacetic acid, bis(trimethylsilyl)	1.57	Ester	6398-62-5	$C_8H_{20}O_2SSi_2$	236.48
12	38.335	Nonadecane	1.41	Hydrocarbon	629-92-5	$C_{19}H_{40}$	268.52
13	39.561	Methyl 7,10,13,16,19-docosapentaenoate	1.28	Ester	None	$C_{23}H_{38}O_2$	344.53
14	39.951	5,8,11-Heptadecatrien-1-ol	1.27	Alcohol	22117-09-5	$C_{17}H_{30}O$	250.42
15	31.367	3-Hydroxy-2,4,4-trimethylpentyl-ester-2-methyl-propanoic acid	1.08	Ester	74367-34-3	$C_{12}H_{24}O_3$	216.32
16	34.907	2,6,10-Trimethyltetradecane	1.06	Hydrocarbon	14905-56-7	$C_{17}H_{36}$	240.47
17	31.450	Copaene	1.03	Hydrocarbon	3856-25-5	$C_{15}H_{24}$	204.35
18	32.929	Caryophyllene	0.87	Hydrocarbon	87-44-5	$C_{15}H_{24}$	204.35
19	30.539	Propanoic acid, 2-methyl-, 2,2-dimethyl-	0.70	Ester	74367-33-2	$C_{12}H_{24}O_3$	216.32
20	31.030	γ-Nonalactone	0.70	Ketone	104-61-0	$C_9H_{16}O_2$	156.22
21	37.724	Methyl stearidonate	0.70	Ester	None	$C_{18}H_{28}O_2$	276.41
22	43.814	Heneicosane	0.61	Hydrocarbon	629-94-7	$C_{21}H_{44}$	296.57
23	33.012	α-Ionone	0.56	Aldehyde	127-41-3	$C_{13}H_{20}O$	192.30
24	33.310	α-Bergamotene	0.52	Hydrocarbon	17699-05-7	$C_{15}H_{24}$	204.35
25	32.200	Pentadecane	0.51	Hydrocarbon	629-62-9	$C_{15}H_{32}$	212.41
26	36.310	Heptadecane, 2,6,10,15-tetramethyl-	0.46	Hydrocarbon	54833-48-6	$C_{21}H_{44}$	296.57
27	39.004	Phenol,2,6-bis(1,1-dimethylethyl)-4-(1-methylpropyl)-	0.40	Alcohol	17540-75-9	$C_{18}H_{30}O$	262.43
28	47.009	Methyl heptacosanoate	0.36	Ester	55682-91-2	$C_{28}H_{56}O_2$	424.74
29	48.648	Ethyl palmitate	0.36	Ester	628-97-7	$C_{18}H_{36}O_2$	284.48
30	50.907	Propanedioic acid, bis[2-(trimethylsilyl)ethyl] ester	0.35	Ester	90744-45-9	$C_{13}H_{28}O_4Si_2$	304.53
31	35.673	β-Bisabolene	0.35	Hydrocarbon	495-61-4	$C_{15}H_{24}$	204.35
32	52.453	Rhodopin	0.24	Alcohol	105-92-0	$C_{40}H_{58}O$	554.89

Table 3. Changes of EEG power spectrum values before and during the inhalation of essential oil of *M. arvensis*

Site	Relative gamma (μV)		Relative fast alpha (μV)		Spectral edge frequency 90% (μV)	
	Before	During	Before	During	Before	During
Fp1 - Left prefrontal	0.096±0.064	0.075±0.027	0.059±0.028	0.070±0.040	25.678±8.948	23.894±7.580
Fp2 - Right prefrontal	0.097±0.056	0.083±0.036	0.058±0.023	0.065±0.031	24.122±9.016	23.984±8.916
F3 - Left frontal	0.053±0.025	0.043±0.022*	0.064±0.039	0.074±0.045	22.156±6.894	20.713±5.560*
F4 - Right frontal	0.051±0.031	0.041±0.024	0.062±0.041	0.070±0.042*	20.788±7.308	19.806±5.909
T3 - Left temporal	0.129±0.065	0.105±0.065	0.069±0.052	0.076±0.035	29.384±8.790	27.741±7.842
T4 - Right temporal	0.128±0.069	0.113±0.053	0.071±0.052	0.069±0.032	28.969±9.319	28.688±8.225
P3 - Left parietal	0.053±0.029	0.047±0.021	0.101±0.076	0.107±0.056	21.884±6.524	20.888±5.549
P4 - Right parietal	0.052±0.034	0.046±0.026	0.102±0.063	0.101±0.063	21.078±7.267	20.947±6.022

Values are mean±standard deviation.
*Significant differences ($p<0.05$) during the fragrant inhalation.

EEG activity

The changes of EEG power spectrum values of brain due to the inhalation of MAO are presented in Table 3. Among the values of 25 indices analyzed, significant changes were observed in the values of relative gamma, relative fast alpha and spectral edge frequency 90%. The t-mapping of brain

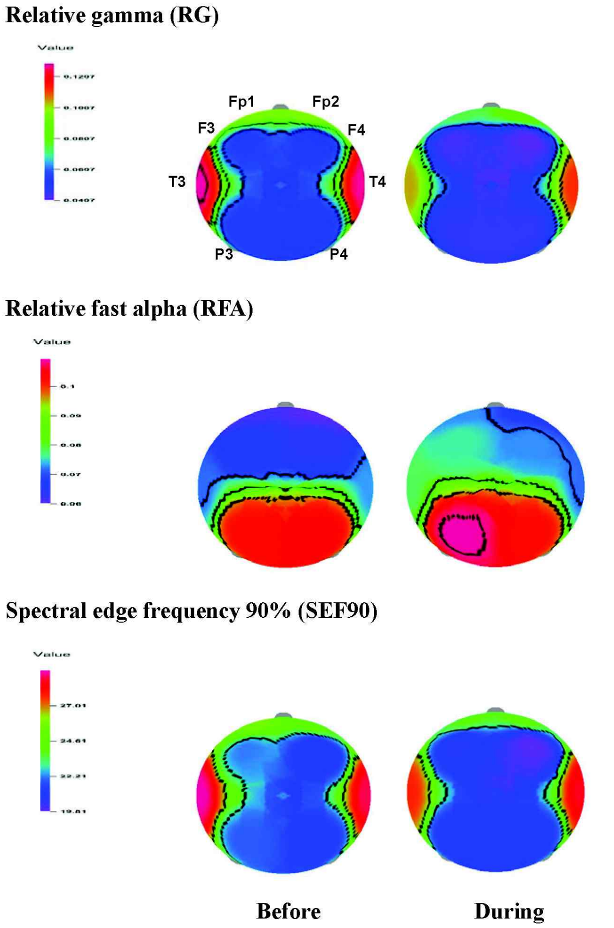

Fig. 2. t-Mapping of relative gamma, relative fast alpha and spectral edge frequency 90% brain waves before and during the inhalation of essential oil of *M. arvensis*. Fp1, left prefrontal; Fp2, right prefrontal; F3, left frontal; F4, right frontal; T3, left temporal; T4, right temporal; P3, left parietal; P4, right parietal.

expressed the changes of these EEG waves before and during the exposure of MAO (Fig. 2). After the inhalation of MAO, the EEG power spectrum values were changed significantly with increase of fast alpha and decrease of relative gamma and spectral edge frequency 90% waves. These changes were observed maximum in the frontal and temporal regions. The relative gamma values highly decreased in the left (Fp1) and right prefrontal (Fp2) regions from 0.096 to 0.075 μV and from 0.097 to 0.083 μV, respectively. In the left (T3) and right temporal (T4) regions also decreased from 0.129 to 0.105 μV and from 0.128 to 0.113 μV, respectively. Whereas, the values of fast alpha waves significantly increased ($p<0.05$) in the right frontal region from 0.062 to 0.070 μV.

Discussion

Aromatic plants are commonly used in the traditional system of medicine. Essential oils extracted from them are widely used for the treatments of various diseases, such as cancer, cardiovascular diseases, atherosclerosis, thrombosis, bacterial and viral infections [8]. Generally, essential oils are extracted by conventional methods such as hydro-distillation, steam distillation and solvent extraction. However, the limitations of these techniques are thermal degradation, partial hydrolysis, incomplete extraction, solvent residues and post-extraction process [5]. Therefore, supercritical fluid extraction (SFE) of active compounds from plant material is an alternative technique and has certain advantages over steam-distillation and solvent extraction. SFE can be performed at lower temperatures, thereby preserving the original extract composition and properties [17]. Carbon dioxide is the most desirable solvent for supercritical fluid extraction for the extractions of fragrances and other active compounds. In addition, it is an inert, non-flammable, non-toxic, inexpensive, odorless and generally accepted a harmless ingredient in pharmaceuticals, cosmetics and food [4, 17, 26]. Hence, SFE was performed for the extraction of essential oil from aerial parts of *M. arvensis*. In the present study, results of SFE revealed that extraction temperature and pressure were the dominant factors to affect the yield of essential oil isolated from *M. arvensis*. Thus, the best conditions obtained for the extraction of MAO were temperature at 70°C and pressure at 200 bar. Similarly, Khajeh et al. [11] studied the effects of pressure and temperature on the SFE of *Ferula assa-foetida* oil. The results showed that the extraction yield was higher under a pressure of 300 bar and temperature 35°C. Baysal and Starmens [3] studied that SFE of caraway seed and their results showed that the parameters of pressure and temperature were played major roles on the extraction yield. They suggested that at moderate temperature (31.1°C) and pressure (73.8 bar), the extraction yield was considerably higher. Since the parameters of temperature and pressure potentially affect the extraction yield, the optimization of the experimental conditions represents a crucial step in the development of a SFE method.

In the present study, the major compound (*Z,Z,Z*)-9,12,15-octadecatrien-1-ol has been previously identified in *Camellia taliensis*. Among 28 aroma components from the volatile oils of *Camellia taliensis*, (*Z,Z,Z*)-9,12,15-octadecatrien-1-ol present up to 1.2% in tender leaves and 11.2% in older leaves [28]. Verma et al. [27] reported that the essential oil of *M. arvensis* mainly composed of menthol, menthone, isomenthone, menthyl acetate, limonene and neomenthol. Further, stated that the essential oil content and terpenoids composition of *M. arvensis* were found to vary with respect to crop age. The chemical composition of plant essential oils may vary according to species, part of the plant, season of harvesting and geographical origin [10, 24]. In addition, the extraction methods can also influence the type and amount of molecules extracted [2, 14].

In EEG study, inhalation of MAO provided significant changes on EEG power spectrum values of relative gamma, relative fast alpha and spectral edge frequency 90%. Iijima et al. [9] reported that the fast alpha activity increased significantly during agarwood incense exposure compared to that during rose oil exposure. Similarly, the present study reveals that the increase of fast alpha waves during the inhalation MAO when compared to before inhalation. Sayowan et al. [19] demonstrated that the inhalation of lavender oil increased the theta and alpha power spectrum values in all the regions. Further, the author suggested that the increase of alpha wave activity is highly correlated to the relaxation effect of brain. Previously, several studies have stated that alpha activity was increased significantly due to the inhalation of fragrances and provided relaxing effect on brain activity [6, 9, 19]. The results of present study showed that the increase of fast alpha waves enhanced the attention and relaxation effects of brain functions. The alpha activity (8-13 Hz) is one of the fundamental electrophysiological events of the human electroencephalogram (EEG). Klimesch (12) described that the EEG oscillations in the alpha wave is positively related to cognitive performance and brain maturity. Further, the author stated that alpha frequency shows large inter-individual differences which are related to age and memory performances. Motomura et al. [15] suggested that the exposure of lavender oil increased the level of theta 1 waves and decreased the level of beta waves. These changes could be attributed to reducing stress state associated with relaxation. The present investigation revealed that the decrease of relative gamma waves reduced the mental tension, anxiety and excited states of human brain.

In addition, the decrease of SEF90 values during the inhalation of MAO is attributed to the reduction of excessive anxiety, tension, anxiousness, or emotional states. The spectral edge frequency is calculated from the power in frequency ranges. The area under the curve of the power spectrum is calculated first. Following the frequency is derived that separates 90% of the area from 10% of the area is called as SEF90. The spectral edge frequency may increase during light anaesthesia and then decrease at deeper levels [25]. Schwender et al. [20] stated that the SEF90 is reduced with increasing the concentration of anaesthetics. Furthermore, it has been suggested that SEF may be used to measure depth of anaesthesia and indicate arousal during emergence from general anaesthesia.

Overall results in the study show that the higher yield of essential oil was obtained through SFE at 70°C and 200 bar pressure. The GC/MS analysis of essential oil indicated that the separation of 32 components. Further, the present investigation indicates that the brain wave activities in related to mood and stress states were affected by the exposure of *M. arvensis* essential oil. This study provides evidence that *M. arvensis* essential oil as a potential source of aromatic compounds with great potential on the treatment of psychophysiological disorders.

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초록 : 박하(*Mentha arvensis*) 향료의 향기성분이 정신적 스트레스 완화에 미치는 효과

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본 연구는 박하(*Mentha arvensis*) 식물 유래 향료의 향기성분을 구명하고, 향기성분들이 인간의 뇌파에 어떠한 영향을 미치는지를 이해하고자 수행하였다. 초임계추출기를 이용하여 박하 식물(*Mentha arvensis* L. f. *piperascens*)로부터 에센셜오일을 얻었으며, 최적 회수율은 70°C, 200 bar 조건에서 2.38%이었다. 박하 에센셜오일에 함유되어 있는 향기 화합물을HS-SPME/GC-MS로 분석한 결과, 총 32종의 화합물이 검출되었는데 alcohol 류가 6종(67.11%), hydrocarbon 류가 13종(17.05%), ester 류가 9종(11.50%), ketone 류가 2종(7.16%), oxide가 1종(2.77%) 그리고 aldehyde가 1종(0.56%)이었다. 박하 에센셜오일에 함유된 주된 향기 화합물은 (*Z,Z,Z*)-9,12,15-octadecatrien-1-ol (50.06%), 2-hydroxy-4-methoxyacetophenone (7.50%)과 3,4-dihydro-8-hydroxy-3-methyl-1H-2-benzopyran-1-one (6.60%) 이었다. 총 20명의 피험자(남녀 각 10명)를 대상으로 박하 에센셜오일 향기 흡입 전과 흡입 중에 뇌파분석을 수행한 결과, 향기를 흡입 중에는, 흡입 전과 비교하여, relative fast alpha power spectrum이 유의성 있게 증가하는 반면($p<0.05$), gamma power spectrum과 spectral edge frequency 90% 지표는 유의성 있게 감소하는 결과를 얻었다($p<0.05$). 본 연구의 결과들은 박하의 향기성분이 정신적 긴장을 완화시킨다는 것을 시사하여 준다.