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천연 약초 추출 향이 뇌파 활성과 자율신경계에 미치는 영향

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Effects of Natural Herbal Extracts on Electrical Brain Activity and Autonomic Nervous System

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요 약: 문헌에 따르면, 천연 추출물 또는 천연 에센셜 오일을 포함한 화장품 향의 흡입으로 뇌파 변화가 유도된다는 사례가 보고되어 있다. *Angelica gigas* (AG)와 *Cnidium officinale* (CO)는 건강을 개선하는 전통 약재로 동아시아 국가에서 널리 사용되고 있으나, 이들의 향을 흡입하여 뇌파(EEG)기록을 통해 뇌 활동 변화를 평가한 이전 보고는 없었다. 본 연구에서는, *Artemisia princeps* var. *orientalis* (Compositae), AG, and CO와 같은 천연 약초 추출물의 향을 흡입하고 후각 자극으로 감정적인 상태 변화가 야기되는지에 대한 평가를 하였으며, 20 ~ 30 세 시험대상자를 대상으로 천연 약초 추출물의 향을 흡입하기 전과 후에 뇌 활동을 EEG기록을 통해 확인하였다. 또한 향을 흡입하는 동안 자율신경계 변화는 심전도(ECG) 기록을 통해 심장의 전기적 활동을 관찰하였다. 시험 결과, 양성 대조군인 라벤더를 포함하여 Compositae, AG, CO 추출물의 향을 맡으면 뇌의 전반 영역에서 뇌파의 relative alpha power 와 alpha/beta ratio가 크게 증가하는 결과를 나타냈다. ECG 기록은 Compositae 향의 흡입이 low-frequency/high-frequency 비율을 유의미한 수준으로 감소시켰다. 결론적으로 전통 약초 추출물 향의 흡입은 뇌파와 자율신경계 변화가 유도하여 감성적 편안함과 심리적 안정감에 도움을 줄 수 있음을 확인하였다.

Abstract: In the literature, inhalation of cosmetic fragrances, including natural extracts or natural essential oils, has been reported to induce brainwave changes. *Angelica gigas* (AG) and *Cnidium officinale* (CO) are widely used in East Asian countries as traditional medicines to improve health, but there have been no previous reports of inhaling their aromas and assessing changes in brain activity through electroencephalogram (EEG) recordings. In this study, the scent of natural herbal extracts such as *Artemisia princeps* var. *orientalis* (Compositae), AG, and CO was inhaled and evaluated whether emotional state changes were caused by olfactory stimuli, and brain activity was confirmed through EEG records before and after inhaling the scent of natural herbal extracts in subjects aged 20 to 30. We also used an electrocardiogram (ECG) to record the electrical activity of the heart during fragrance administration. The test results indicated that inhaling the scents of Compositae, AG, and CO extracts, as well as the positive control lavender, significantly increased the relative alpha power and the alpha/beta ratio of brain waves across the brain regions. The ECG recordings indicated that the inhalation of Compositae fragrance significantly decreased the low-frequency/high-frequency ratio, and that the inhalation of traditional herbal extract fragrances resulted in comfort and relaxation.

Keywords: *brain wave, olfactory stimulation, Angelica gigas, Cnidium officinale, Compositae*

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1. Introduction

Prior studies have used various techniques to clarify the physiological, psychological, and emotional effects of fragrances on humans[1–5]. A questionnaire is a useful tool that can recognize sensory effects; however, its results are subjective. By using an electroencephalogram (EEG) to recognize emotions, it is possible to measure modifications in brain activity induced by inhaling fragrances. Brain activity has been measured in previous studies, where it was indicated that the inhalation of essential oil fragrances can have positive psychological effects, such as stress reduction, relaxation enhancement, and alertness enhancement[6–8]. Psychological changes caused by exposure to a fragrance are related to modulation of the olfactory nervous system and subsequent shifts in neuronal activity[9]. Additionally, human EEG activity is susceptible to alterations during fragrance stimulation[10], therefore, several studies show electroencephalogram change through inhalation of fragrance such as lavender and rosemary[8,11]. As previously reported, molecules absorbed during inhalation can cross the blood–brain barrier and interact with receptors in the central nervous system[12].

Cosmetic formulations including natural extracts or natural essential oils can induce brain wave changes associated with the tactile and olfactory senses. *Artemisia princeps* var. *orientalis* (Compositae), *Angelica gigas* (AG), and *Cnidium officinale* (CO) have been used as traditional herbal medicines to improve human health in East Asian countries and are potent inhibitors of inflammation and oxidative stress. However, the effects of inhalation of their fragrances on olfactory perception and cerebroelectrical activity have not been evaluated using an EEG. Therefore, we performed a sensory evaluation using a methodological paradigm involving the inhalation of traditional herbal extract fragrances through electrocardiogram (ECG) and EEG recordings.

2. Methods

2.1. Participants

Twenty-four healthy participants (12 male and 12 female) 20 ~ 30 years of age (mean age, 24.5 yrs ± 2.5) were evaluated to determine any excessive nasal congestion, drug use, and neurological disorders before participation in this study. All participants provided informed consent before the study was initiated (Institutional Review Board (IRB) approval no. P1703-94).

2.2. Procedures

An experiment room was blocked from outside sound and maintained at a temperature of 20 ~ 25 ℃ with a relative humidity level of 40 ~ 60%. Participants individually entered the room, and electrode gear was affixed to the head. During each study condition, EEG recordings were performed while the participant sat and rested in a chair. All participants kept their eyes closed and minimized movement during recordings. To allow the participant to inhale the fragrance, the researcher soaked a scent strip with herbal extracts and fragrance (positive control) to a depth of approximately 2 cm and gently waved it back and forth at regular intervals in front of the participant's nose during the measurement period. EEG recordings were performed during 3 min of rest and 3 min of fragrance administration. The participants conducted the experiment while seated in a comfortable chair in a soundproof EEG measurement room where temperature and humidity were consistently maintained. The sequence of presenting the fragrances was counterbalanced for each participant. The room was ventilated during the 2 min intervals between recordings.

2.3. EEG and ECG Recordings

The EEG recordings were obtained using the DSI-24 electrode system (Wearable Sensing, USA) placed in 18 scalp positions (F3, Fz, F4, Fp1, Fp2, F7, F8, C3, C4, Cz, T3, T4, P3, P4, T5, O1, O2, and T6) based on the international 10 ~ 20 system. The alpha (8 ~ 13 Hz) and beta (14 ~ 30 Hz) waves we aim to observe are detected at these 18 positions. Alpha waves predominantly appear in a relaxed state, whereas beta waves are more prominent in an alert state[11,13,14]. Therefore, examining the ratio of alpha to beta waves can indicate a state of relaxation if beta wave activity decreases or alpha wave activity increases after exposure to the fragrance. Additionally, an increase in high-frequency, indicative of parasympathetic activity (HF) in the ECG measurements signifies a relaxed state, whereas an increase in low-frequency, indicative of sympathetic activity (LF) signifies a tense state. Therefore, an increase in the LF/HF (sympathetic/ parasympathetic) ratio along with a decrease in heart rate can be interpreted as an indication of a relaxed state[14]. All electrodes were linked to the A1 and A2 earlobe sites. The EEG data were analyzed using Telescan software (Laxtha Inc., Korea). The EEG and ECG recordings were simultaneously obtained during inhalation.

2.4. Preparation of Traditional Herbal Extracts

Compositae, CO, and AG extracts were obtained and placed in 60 mL or 80 mL of water mixed with propylene glycol or butylene glycol. In this experiment, lavender oil (Samhwa F&F., Korea), which is widely recognized for its relaxing effects, was utilized as the positive control substance.

2.5. Statistical Analysis

A statistical analysis was performed using SPSS 23.0 (SPSS, Inc., USA) to evaluate significant changes in brain waves following the inhalation of each fragrance compared to the resting (no odor) state. The paired *t*-test and Wilcoxon signed-rank test were performed as appropriate.

3. Results

As reported by a previous study, the inhalation of lavender oil fragrance increased alpha brain activity; consequently, the participants felt more relaxed than they did after inhalation of the base oil fragrance[7,11]. The statistical comparison between the rest condition (no odor state) and the state of inhaling lavender scent revealed that the inhalation of lavender fragrance increased relative alpha power across various brain areas, including the prefrontal, central, temporal, and occipital lobes (Table 1).

Interestingly, the inhalation of Compositae, AG, and CO fragrances significantly enhanced relative alpha power across all brain regions, demonstrating a statistically significant difference when compared to the rest (no odor) condition (Tables 2, 3, 4).

Additionally, the inhalation of lavender fragrance significantly enhanced the alpha/beta ratio in areas of the right hemisphere, such as F4, C4, and P4, as well as the central lobe, such as C3 and C4, showing a statistically significant difference compared to the rest (no odor state) condition (Table 5).

A statistically significant increase in the alpha/beta ratio was observed across all brain regions following the inhalation of Compositae, AG, and CO fragrances, compared to the rest (no odor) condition (Tables 6, 7, 8).

Next, the low frequency (LF)/high frequency (HF) ratio, which is a characteristic of sympathetic and parasympathetic activation of the heart rate, was analyzed based on ECG recordings and compared with the Rest state. Previous reports have shown that lavender oil inhalation decreases blood pressure, heart rate, and skin temperature, leading to a reduction in autonomic arousal[7]. In this study, the LF/HF ratio for lavender slightly increased, although this change was not statistically significant. The LF/HF ratio exhibited diminishing tendencies following the inhalation of traditional

Table 1. The Change in Relative Alpha Power after Inhaled Lavender Oil

Lavender			
Site	Mean relative alpha power (Mean ± SD)		p value
	Rest	Lavender	
F3	0.505 ± 0.199	0.536 ± 0.226	0.064
Fz	0.527 ± 0.201	0.556 ± 0.213	0.083
F4	0.486 ± 0.215	0.531 ± 0.214	0.012#
Fp1	0.513 ± 0.213	0.543 ± 0.219	0.029*
Fp2	0.510 ± 0.212	0.539 ± 0.220	0.022*
F7	0.496 ± 0.211	0.516 ± 0.224	0.212
F8	0.475 ± 0.216	0.487 ± 0.222	0.036#
C3	0.470 ± 0.195	0.515 ± 0.213	0.037*
C4	0.469 ± 0.203	0.520 ± 0.215	0.003*
Cz	0.512 ± 0.194	0.546 ± 0.208	0.080
T3	0.471 ± 0.190	0.499 ± 0.208	0.095
T4	0.463 ± 0.195	0.498 ± 0.214	0.022*
P3	0.417 ± 0.171	0.440 ± 0.187	0.164
P4	0.405 ± 0.158	0.445 ± 0.185	0.007#
T5	0.508 ± 0.175	0.543 ± 0.187	0.023#
O1	0.499 ± 0.201	0.555 ± 0.180	0.003*
O2	0.538 ± 0.177	0.567 ± 0.204	0.199
T6	0.504 ± 0.181	0.559 ± 0.184	0.001*

* : $p < 0.05$ by paired *t*-test
# : $p < 0.05$ by Wilcoxon signed rank test

Table 2. The Change in Relative Alpha Power after Inhaled Compositae

Artemisia princeps var. *orientalis* (Compositae)			
Site	Mean relative alpha power (Mean ± SD)		p value
	Rest	Compositae	
F3	0.505 ± 0.199	0.582 ± 0.215	0.000#
Fz	0.527 ± 0.201	0.594 ± 0.207	0.001#
F4	0.486 ± 0.215	0.572 ± 0.211	0.000#
Fp1	0.513 ± 0.213	0.570 ± 0.206	0.000#
Fp2	0.510 ± 0.212	0.572 ± 0.209	0.000#
F7	0.496 ± 0.211	0.554 ± 0.213	0.002*
F8	0.475 ± 0.216	0.556 ± 0.212	0.000*
C3	0.470 ± 0.195	0.567 ± 0.205	0.000#
C4	0.469 ± 0.203	0.551 ± 0.211	0.000#
Cz	0.512 ± 0.194	0.599 ± 0.195	0.000#
T3	0.471 ± 0.190	0.562 ± 0.191	0.000*
T4	0.463 ± 0.195	0.534 ± 0.214	0.002*
P3	0.417 ± 0.171	0.501 ± 0.175	0.000#
P4	0.405 ± 0.158	0.494 ± 0.169	0.000#
T5	0.508 ± 0.175	0.596 ± 0.172	0.000*
O1	0.499 ± 0.201	0.599 ± 0.173	0.003*
O2	0.538 ± 0.177	0.602 ± 0.193	0.006#
T6	0.504 ± 0.181	0.583 ± 0.179	0.002#

*: $p < 0.05$ by paired t-test
#: $p < 0.05$ by Wilcoxon signed rank test

Table 3. The Change in Relative Alpha Power after Inhaled AG

Angelica gigas (AG)			
Site	Mean relative alpha power (Mean ± SD)		p value
	Rest	AG	
F3	0.505 ± 0.199	0.578 ± 0.212	0.000*
Fz	0.527 ± 0.201	0.595 ± 0.202	0.000#
F4	0.486 ± 0.215	0.554 ± 0.217	0.018*
Fp1	0.513 ± 0.213	0.581 ± 0.207	0.000#
Fp2	0.510 ± 0.212	0.577 ± 0.205	0.000#
F7	0.496 ± 0.211	0.566 ± 0.207	0.000#
F8	0.475 ± 0.216	0.534 ± 0.218	0.000#
C3	0.470 ± 0.195	0.559 ± 0.203	0.001*
C4	0.469 ± 0.203	0.563 ± 0.203	0.000#
Cz	0.512 ± 0.194	0.588 ± 0.205	0.001*
T3	0.471 ± 0.190	0.553 ± 0.178	0.000*
T4	0.463 ± 0.195	0.540 ± 0.189	0.000*

Table 3. (Continued)

Angelica gigas (AG)			
Site	Mean relative alpha power (Mean ± SD)		p value
	Rest	AG	
P3	0.417 ± 0.171	0.491 ± 0.178	0.000#
P4	0.405 ± 0.158	0.493 ± 0.158	0.000#
T5	0.508 ± 0.175	0.595 ± 0.158	0.000*
O1	0.499 ± 0.201	0.585 ± 0.167	0.002*
O2	0.538 ± 0.177	0.602 ± 0.186	0.003#
T6	0.504 ± 0.181	0.590 ± 0.162	0.002*

*: $p < 0.05$ by paired t-test
#: $p < 0.05$ by Wilcoxon signed rank test

Table 4. The Change in Relative Alpha Power after Inhaled CO

Cnidium officinale (CO)			
Site	Mean relative alpha power (Mean ± SD)		p value
	Rest	CO	
F3	0.505 ± 0.199	0.574 ± 0.221	0.002*
Fz	0.527 ± 0.201	0.593 ± 0.203	0.001*
F4	0.486 ± 0.215	0.572 ± 0.219	0.001*
Fp1	0.513 ± 0.213	0.578 ± 0.206	0.000*
Fp2	0.510 ± 0.212	0.575 ± 0.208	0.001*
F7	0.496 ± 0.211	0.564 ± 0.211	0.001*
F8	0.475 ± 0.216	0.532 ± 0.222	0.008*
C3	0.470 ± 0.195	0.556 ± 0.210	0.001*
C4	0.469 ± 0.203	0.534 ± 0.220	0.004*
Cz	0.512 ± 0.194	0.590 ± 0.200	0.001*
T3	0.471 ± 0.190	0.531 ± 0.206	0.014*
T4	0.463 ± 0.195	0.539 ± 0.206	0.000*
P3	0.417 ± 0.171	0.490 ± 0.190	0.005*
P4	0.405 ± 0.158	0.495 ± 0.159	0.000*
T5	0.508 ± 0.175	0.577 ± 0.177	0.003#
O1	0.499 ± 0.201	0.578 ± 0.179	0.004#
O2	0.538 ± 0.177	0.607 ± 0.190	0.006#
T6	0.504 ± 0.181	0.590 ± 0.174	0.009*

*: $p < 0.05$ by paired t-test
#: $p < 0.05$ by Wilcoxon signed rank test

Table 5. The Change of Alpha/beta Ratio after Inhaled Lavender

Lavender			
Site	Alpha/beta ratio (Mean ± SD)		p value
	Rest	Lavender	
F3	4.053 ± 3.969	4.617 ± 4.509	0.056
Fz	4.326 ± 4.135	4.846 ± 4.590	0.424
F4	3.985 ± 3.709	4.529 ± 4.357	0.036#
Fp1	4.277 ± 4.343	4.792 ± 4.645	0.070
Fp2	4.132 ± 4.110	4.681 ± 4.518	0.038
F7	3.902 ± 3.713	4.482 ± 4.371	0.103
F8	3.713 ± 3.457	4.036 ± 3.868	0.230
C3	3.237 ± 3.288	3.759 ± 3.431	0.044#
C4	3.209 ± 2.936	3.930 ± 3.721	0.004#
Cz	3.606 ± 3.194	4.270 ± 3.744	0.166
T3	3.265 ± 3.207	3.667 ± 3.457	0.179
T4	3.212 ± 3.047	3.720 ± 3.513	0.006
P3	2.276 ± 2.302	2.445 ± 2.233	0.411
P4	2.037 ± 1.553	2.371 ± 1.890	0.018#
T5	3.365 ± 2.648	3.656 ± 2.779	0.089
O1	3.380 ± 2.717	3.710 ± 2.693	0.121
O2	3.752 ± 2.638	4.178 ± 2.857	0.253
T6	3.334 ± 2.426	3.732 ± 2.549	0.085

: $p < 0.05$ by Wilcoxon signed rank test

Table 6. The Change of Alpha/beta Ratio after Inhaled Compositae

Artemisia princeps var. *orientalis* (Compositae)			
Site	Alpha/beta ratio (Mean ± SD)		p value
	Rest	Compositae	
F3	4.053 ± 3.969	5.267 ± 4.770	0.001#
Fz	4.326 ± 4.135	5.493 ± 4.714	0.003#
F4	3.985 ± 3.709	5.023 ± 4.505	0.002#
Fp1	4.277 ± 4.343	5.263 ± 4.637	0.001#
Fp2	4.132 ± 4.110	5.170 ± 4.532	0.001#
F7	3.902 ± 3.713	4.911 ± 4.429	0.001#
F8	3.713 ± 3.457	4.836 ± 4.350	0.003#
C3	3.237 ± 3.288	4.594 ± 4.183	0.000#
C4	3.209 ± 2.936	4.443 ± 4.060	0.000#
Cz	3.606 ± 3.194	4.896 ± 4.896	0.001#
T3	3.265 ± 3.207	4.358 ± 3.858	0.000#
T4	3.212 ± 3.047	4.319 ± 4.001	0.000#

Table 6. (Continued)

Artemisia princeps var. *orientalis* (Compositae)			
Site	Alpha/beta ratio (Mean ± SD)		p value
	Rest	Compositae	
P3	2.276 ± 2.302	2.928 ± 2.397	0.000#
P4	2.037 ± 1.553	2.713 ± 1.891	0.000#
T5	3.365 ± 2.648	4.368 ± 2.897	0.001*
O1	3.380 ± 2.717	4.471 ± 2.905	0.001*
O2	3.752 ± 2.638	4.616 ± 2.811	0.005*
T6	3.334 ± 2.426	4.045 ± 2.466	0.008*

* : $p < 0.05$ by paired t-test
# : $p < 0.05$ by Wilcoxon signed rank test

Table 7. The Change of Alpha/beta Ratio after Inhaled AG

Angelica gigas (AG)			
Site	Alpha/beta ratio (Mean ± SD)		p value
	Rest	AG	
F3	4.053 ± 3.969	5.009 ± 4.154	0.001*
Fz	4.326 ± 4.135	5.281 ± 4.263	0.000*
F4	3.985 ± 3.709	4.685 ± 3.812	0.012*
Fp1	4.277 ± 4.343	5.211 ± 4.296	0.000*
Fp2	4.132 ± 4.110	5.034 ± 4.018	0.000#
F7	3.902 ± 3.713	4.667 ± 3.710	0.001*
F8	3.713 ± 3.457	4.310 ± 3.595	0.029*
C3	3.237 ± 3.288	4.159 ± 3.318	0.002#
C4	3.209 ± 2.936	4.247 ± 3.344	0.000#
Cz	3.606 ± 3.194	4.754 ± 3.643	0.001#
T3	3.265 ± 3.207	3.803 ± 2.821	0.002#
T4	3.212 ± 3.047	3.982 ± 3.292	0.000#
P3	2.276 ± 2.302	2.727 ± 2.152	0.002#
P4	2.037 ± 1.553	2.612 ± 1.666	0.001*
T5	3.365 ± 2.648	4.037 ± 2.597	0.011*
O1	3.380 ± 2.717	3.994 ± 2.538	0.003*
O2	3.752 ± 2.638	4.344 ± 2.602	0.029*
T6	3.334 ± 2.426	3.901 ± 2.244	0.009*

* : $p < 0.05$ by paired t-test
# : $p < 0.05$ by Wilcoxon signed rank test

Table 8. The Change of Alpha/beta Ratio after Inhaled CO

Site	*Cnidium officinale* (CO) Alpha/beta ratio (Mean ± SD) Rest	CO	p value
F3	4.053 ± 3.969	5.102 ± 4.393	0.000#
Fz	4.326 ± 4.135	5.375 ± 4.471	0.002#
F4	3.985 ± 3.709	4.898 ± 4.087	0.004#
Fp1	4.277 ± 4.343	5.207 ± 4.403	0.015*
Fp2	4.132 ± 4.110	4.953 ± 3.979	0.005#
F7	3.902 ± 3.713	4.916 ± 4.240	0.003#
F8	3.713 ± 3.457	4.704 ± 3.980	0.011#
C3	3.237 ± 3.288	4.183 ± 3.378	0.004#
C4	3.209 ± 2.936	4.359 ± 3.672	0.000#
Cz	3.606 ± 3.194	4.858 ± 3.881	0.004#
T3	3.265 ± 3.207	3.782 ± 2.893	0.059
T4	3.212 ± 3.047	4.268 ± 3.783	0.000#
P3	2.276 ± 2.302	2.899 ± 2.033	0.006#
P4	2.037 ± 1.553	2.650 ± 1.734	0.001#
T5	3.365 ± 2.648	3.908 ± 2.517	0.067
O1	3.380 ± 2.717	4.091 ± 2.548	0.035*
O2	3.752 ± 2.638	4.457 ± 2.530	0.063
T6	3.334 ± 2.426	4.052 ± 2.265	0.024*

*: $p < 0.05$ by paired t-test
#: $p < 0.05$ by Wilcoxon signed rank test

herbal extract fragrances. Additionally, the LF/HF ratio significantly decreased after the inhalation of the Compositae fragrance (Table 9). Moreover, during this study, inhalation of the Compositae fragrance resulted in the most relaxed and optimal psychophysiological state.

Table 9. The Change of LF/HF Ratio

Site	LF/HF ratio Rest (Mean ± SD)	Fragrance (Mean ± SD)	p value
Lavender	1.098 ± 0.936	1.126 ± 1.279	0.668
Compositae	1.098 ± 0.936	0.830 ± 0.953	0.022*
AG	1.098 ± 0.936	0.878 ± 0.771	0.067
CO	1.098 ± 0.936	0.842 ± 0.674	0.076

*: $p < 0.05$ by paired t-test
Artemisia princeps var. *orientalis* (Compositae), *Angelica gigas* (AG), *Cnidium officinale* (CO)

4. Discussion and Conclusion

Fragrances, such as those associated with perfumes and other scented products, can induce changes in emotions through psychological activities in humans, and their meaningful effects have been gradually promoted by the cosmetics industry. Several studies have shown that the effects of fragrances on emotions are attributable to their direct and intrinsic ability to interact with and affect the central nervous system. An EEG is a precise technique that can be performed to understand the effects of fragrances on brain activity[15]. When analyzing brain wave changes induced by scent, major frequency bands such as alpha, beta, and theta waves are commonly utilized. Typically, an increase in alpha waves indicates a reduction in arousal levels induced by the scent, signifying a state of relaxation, whereas an increase in beta waves indicates a heightened state of arousal[8]. Studies of psychological properties associated with fragrances have most commonly included lavender, and the inhalation of its fragrance has resulted in a more relaxed state than that attributable to the inhalation of base oil fragrances. Sayowan et al demonstrated that the inhalation of lavender fragrance increased alpha waves particularly in the bilateral posterior and anterior areas. Moreover, in terms of mood responses, the subjects felt fresher and relaxed in this study[7]. In current study, the inhalation of lavender oil fragrance enhanced the relative alpha wave and the alpha/beta ratio. Interestingly, the inhalation of traditional herbal extract fragrances induced changes in brain activity. According to the EEG recordings, the relative alpha power and alpha/beta ratio significantly increased in the entire brain after the inhalation of all traditional herbal extract fragrances.

Compositae, AG, and CO are well-known and important plants that have been used as herbal folk medicines that can counteract a variety of diseases, and they are particularly effective against inflammatory diseases because of their inhibitory effects on oxidative stress and inflammation. Interestingly, Compositae ameliorated scopolamine-induced cognitive impairment in a mouse model[16]. Moreover, the use of AG root extract resulted in improvements in depression and anxiety in an animal model[17]. This is the first study to use EEG recordings of humans to evaluate the ability of traditional herbal extract fragrance inhalation to stabilize emotions.

Because the autonomic nervous system connects the brain and internal organs, we also recorded the electrical activity of the heart using an ECG during fragrance administration. In accordance with previous studies, inhalation of the fragrances extracted from lavender and cedrol induced stimulation of the autonomic nervous function, thus revealing an increase in the HF and decrease in the LF/HF ratio, which are associated with sympathetic activation and parasympathetic activation, during a heart rate variability analysis[18,19]. Interestingly, according to the ECG recordings during our study, the inhalation of Compositae, AG, and CO fragrances decreased the LF/HF ratio, whereas the lavender fragrance resulted in a slight, statistically insignificant increase. The degree of reduction caused by these extracts was greater than the change in the LF/HF ratio induced by lavender. Moreover, the inhalation of the Compositae fragrance resulted in a statistically significant decrease in the LF/HF ratio compared to the no-odor state.

In conclusion, our methodological paradigm comprising EEG and ECG to evaluate the sensory response suggested that the inhalation of traditional herbal extract fragrances can promote relaxation. Therefore, we suggest that Compositae, AG, and CO are potent plants that can be used to develop cosmetic products that can alter emotions.

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