Analysis of Preference in Plant Fragrances and Psychological Evaluation of Firefighter

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ABSTRACT

Background and objective: This study was carried out to investigate and analyze the preference for plant fragrance and the psychological effects of a agro-healing activity in 101 firefighters aged 39.71 ± 10.94 .

Methods: For the psychological evaluation, post-traumatic stress symptoms, Korean occupational stress scale short form (KOSS-SF), emotional intelligence, and job satisfaction were surveyed on the Likert scale. For the preference for plant fragrances, 20 μ l of commercially available essential oils from four plant species (*Mentha* spp., *Lavandula* spp., *Citrus limon*, *C. sinensis*) were absorbed into each test paper and provided to the participants.

Results: The rate of post-traumatic stress symptoms was high at 37.6% of the firefighters surveyed. *C. limon* fragrance had the highest preference among the four plant fragrances, followed by *C. sinensis* > *Mentha* spp. > *Lavandula* spp. with statistically significant difference ($F = 14.256$, $p < .001$). The lower their age, income, and position, and higher the education level, the higher the preference for plant fragrances. And the administrative group had higher preference for plant fragrances than field group. In addition, as a result of examining the correlation between job satisfaction, preference for plant fragrance, post-traumatic stress, emotional intelligence, and job stress for fire-fighters, the higher the job satisfaction, the higher the fragrance preference and emotional intelligence, and the lower the post-traumatic stress and job stress.

Conclusion: Therefore, installing a garden using botanical fragrances at workplaces that firefighters can easily access will improve job satisfaction and relieve stress. It can be concluded that applying the fragrance of plants to the healing farming activities at the fire-fighter's workplace can increase the usefulness of the healing activities.

Keywords: Korean occupational stress scale short form: KOSS-SF, post-traumatic stress symptoms

Introduction

Occupations such as firefighters, police officers, and soldiers are sent to the scenes of various incidents, accidents and disasters and repeatedly exposed to trauma, and thus are considered high-risk occupations likely to lead to post-traumatic stress disorder (PTSD) (Alden et al., 2008; Jeong, 2010; Kwon and You, 2013; Park, 2014; Bercier and Maynard, 2015; Ryu et al., 2017). Firefighters perform

their duties in the front line of disasters with fear and psychological burden in order to keep citizens safe from incidents and disasters that are becoming more massive and complicated (Kim, 2017). In the process of performing various tasks, they suffer from extreme stress as they are exposed to horrible scenes, unstable work environment in which their own safety is at risk, and organization characteristics with a rigid hierarchical structure (Choi and Kim, 2011; Moon, 2017; Kim, 2019). Firefighters in particular

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are frequently exposed to dangerous scenes due to the nature of their job, thereby suffering from more severe physical and emotional stress than other high-risk occupations (The WHOQOL group, 1995; Lee, 2007). If there is limited individual responsiveness to incidents or environments that are likely to cause stress, the risk of suicidal ideation may increase (Zhang et al., 2011). According to a mental health survey conducted on firefighters in Korea by the National Fire Agency in 2018, the rate of increase for firefighters that committed suicide has been higher than that for firefighters that died in the line of duty in the last 10 years (2008-2017) (National Fire Agency: NFA, Feb. 28, 2018). However, there is insufficient research that applied therapeutic programs to reduce physical and psychological stress of firefighters or that examined the effects of such programs.

Among high-risk occupations, firefighters with high post-traumatic stress due to job stress are likely to have lower job satisfaction and higher suicidal ideation (Lee, 2019). In particular, stress primarily causes fatigue, which may be displayed as sleep disorder, demotivation, and lack of concentration (Cha et al., 2008). If these symptoms get worse, they result in industrial accidents, incidents, increased turnover and absence, and decreased job satisfaction (Chang et al., 2004; Cho and Kim, 2015). Considering that the task performance of firefighters is directly linked to the protection of the nation as well as the people, their mental health problems must be approached systematically and preventively at the social and national level, rather than overlooking them as an individual's physical and psychological problems or just negative outcomes (Kim and Kim, 2013). However, therapies or policies for physical and psychological stability of firefighters are not improved in reality, which raises the need for research on actual intervention programs for them.

Recently, stress and irregular routines are pointed out as the causes for many diseases, and the effect of fragrances on stress relief is receiving attention, along with the use of essential oil (Kim, 2005). Moreover, carrying out activities using plant colors (Lee, 2019; Jang et al., 2020) or inhaling pleasant plant fragrances affects the limbic system that is closely related to fear, anxiety, and anger, thereby relieving stress (Martin, 1996). The natural fragrances of

plants in particular affect sleep (Badia et al., 1990), attention (Warm et al., 1991), cognition (Richardson and Zucco, 1989), and memory (Ehrlichman and Bastone, 1992), and are generally known to best provoke human emotions (Ehrlichman and Halpem, 1988). Furthermore, many studies on the positive effects of natural fragrances on stress, anxiety, brain activity, and sleep proved that natural fragrances extracted from plants make people feel better and relieve their depression and stress (Ye, 2002; Lee and Hong, 2010; Lee and Kim, 2011; Koh, 2014; Kim, 2016). Therefore, applying plant fragrances to agro-healing (or care farming) activities for firefighters exposed to high levels of stress will have great psychological effects, making them feel pleasant and secure. However, even though many studies have been conducted on the preference in plant colors or emotions (Guilford and Smith, 1959; Valdez and Mehrabian, 1994; Janssens, 2001; Chong et al., 2004; Ou et al., 2004), there is insufficient research on plant fragrances preferred by firefighters or their emotions.

As there are huge gaps among different generations in terms of individual tastes and preferences such as fragrances, colors, and designs, the differences due to socio-demographic characteristics such as age seem to be increasing. Therefore, this study determines the intergroup differences and distribution of emotional intelligence or preference in plant fragrances according to sociodemographic characteristics of firefighters as well as correlation among key factors such as post-traumatic stress symptoms and job satisfaction. When organizing an agro-healing program for firefighters based on the results, herbs in gardening activities suitable for firefighters, plant fragrances preferred by firefighters, and plant fragrances with a relaxing effect can be applied to indoor healing programs, which can alleviate the negative symptoms of stress for participants and increase positive emotional intelligence, thereby improving job satisfaction of firefighters.

Research Methods

Characteristics of survey respondents

We conducted a survey on 107 firefighters in the fire

departments located in Sunchang and Gimje from September 20 to September 30, 2020 to assess preferences in plant fragrances and emotions for gardening activities of firefighters. We ultimately analyzed 101 copies of the survey excluding 6 copies with inadequate responses. The items were com-

prised of post-traumatic stress symptoms, emotional intelligence, job stress, semantic differential (SD) scale for emotions, job satisfaction scale, sociodemographic characteristics, and preference in plant fragrances in garden formation and gardening. The sociodemographic characteristics included gender, age, educational background, average monthly income, marital status, work type, and work position (Table 1). The preference in plant fragrances and 11 pairs of emotional adjectives for the fragrances were investigated by soaking the tips of fragrance blotter strips with 20 μ l of 4 types of organic natural essential oils (*Mentha* spp., *Lavandula* spp., *Citrus limon*, *Citrus sinensis*) sold in the market (Fig. 1).

Table 1. Characteristic of survey respondents (N = 101)

Variable	Categories	Frequency	Percent (%)
Gender	Male	87	86.1
	Female	14	13.9
Age	20-29s	22	21.8
	30-39s	31	30.7
	40-49s	18	17.8
	50-59s	30	29.7
Education	High school	21	20.8
	University	77	76.2
	Graduate school	3	3.0
Monthly income (Won)	$\leq 3,000,000$	33	32.7
	3,010,000-4,000,000	31	30.7
	4,010,000-5,000,000	19	18.8
	$\geq 5,010,000$	18	17.8
Marital status	Married	63	62.4
	Single	36	35.6
	Divorce/bereavement/separation	2	2.0
Work position	Fire-fighter	33	32.7
	Senior fire sergeant	13	12.9
	Fire sergeant	19	18.8
	$\geq$ Fire lieutenant	36	35.6
Work type	Fire suppression	35	34.7
	Rescue	15	14.9
	First aid	12	11.9
	Administrations	39	38.6

Psychological evaluation tool

Post-traumatic stress symptoms

To analyze post-traumatic stress symptoms, we used the Impact of Event Scale-Revised (IES-R) developed by Horowitz et al. (1979) and revised by Weiss and Marmar (1997) by adding 7 items on arousal. The IES-R is comprised of total 22 items in a self-report questionnaire, reflecting 3 subfactors such as ‘hyperarousal’, ‘avoidance’, and ‘intrusion’, with higher scores on a 5-point Likert scale (0-4) indicating higher post-traumatic stress. Cronbach's α in Weiss and Marmar (1997) was .79, and that in this study was .97.

Korean Occupational Stress Scale Short Form (KOSS-SF)

To measure the job stress of firefighters, we used the Korean Occupational Stress Scale Short Form (KOSS-SF)

Fig. 1. Methods of investigating plant aroma preferences: Injecting natural aroma oil into the pipette (A); Absorption (B); Smell the aroma (C).

developed by Chang et al. (2005) in the study “Developing an occupational stress scale for Korean employees”. It is comprised of 24 items in 7 subfactors such as job demand, insufficient job control, interpersonal conflict, job insecurity, organizational system, lack of reward, and occupational climate rated on a 4-point Likert scale (1 = Strongly disagree - 4 = Strongly agree). Cronbach's α in Chang et al. (2005) was the same as that in this study (Cronbach's $\alpha = .82$).

Emotional intelligence scale

To measure emotional intelligence, we used the emotional intelligence scale developed by Wong and Law (2002) and adapted by Jung (2007). Total 16 items were adjusted to 12 items for this study, comprised of 4 subfactors such as self-emotion appraisal, other-emotion appraisal, emotion regulation, and emotion utilization. These are measured on a 5-point Likert scale (1-5 points), with higher scores indicating higher levels of emotional intelligence. The emotional intelligence scale in this study has Cronbach's $\alpha = .90$, and the internal reliability of the 4 subfactors is as follows: self-emotion appraisal had Cronbach's $\alpha = .82$, other-emotion appraisal had Cronbach's $\alpha = .65$, emotion regulation had Cronbach's $\alpha = .83$, and emotion utilization had Cronbach's $\alpha = .85$.

Job satisfaction

There were no reliability and validity issues in this study, and thus we provided the scale used by Yun (2015) in the job satisfaction survey on police officers on a 5-point Likert scale (1-5 points), with higher scores indicating higher job satisfaction. The job satisfaction survey is comprised of three items assessing self-esteem about the job, sense of reward and pride, and belief: ‘I’m glad I chose this occupation as a firefighter/police officer.’, ‘I take pride in this occupation as a firefighter/police officer.’, and ‘I feel rewarded and proud of my duties.’ Cronbach's α in Yun (2015) was .75, and that in Yoon and Kim (2014) was .91, and Cronbach's α in this study turned out to be .91.

Evaluation of preference in fragrances

Preference in plant fragrances

In general, there are approximately 3,500 species of herbs and spices, and over 300 types of oils that can be used on the human body. Approximately 60 types of oils are mostly used, and some common examples include *Mentha* spp., *Citrus limon*, *Citrus sinensis*, *Rosa* spp., *Lavandula* spp., *Pelargonium* spp., etc. (Oh, 2001). Therefore, 4 types of plant fragrances used in the preference survey in this study are 2 types of herbs that are accessible to the general public in gardening activities and are also easy to take care of (*Mentha* spp., *Lavandula* spp.) and 2 types of fruit fragrances that are easy to buy and edible (*Citrus limon*, *Citrus sinensis*). The fragrances in the preference survey were presented randomly in the preference survey, with higher scores rated on a 5-point Likert scale (1-5 points) indicating higher preference. Cronbach's α of preference in plant fragrances was .45.

Emotions toward plant fragrances using the semantic differential method

The semantic differential (SD) method was developed by Osgood (1952) using adjectives to measure human emotions, and it is widely used in landscaping or appraisals. This study examined the frequency of emotional adjectives about fragrances used in previous studies and selected 11 pairs of emotional adjectives with high frequency. The 11 pairs were presented on a 5-point Likert scale, requiring the respondents to rate them on the level of how close they feel (Jang et al., 2011, 2014). Cronbach's α of 11 pairs of emotional words was .90.

Statistical analysis

Data collected in this study was analyzed using IBM SPSS statistics 25. We conducted one-way ANOVA (post-hoc test: Tukey's multiple range test for job stress according to sociodemographic characteristics of firefighters, 11 pairs of emotions toward plant fragrances in the SD method, and preference in plant fragrances; Pearson's correlation coefficient for the correlation between 11 pairs of emotional adjectives and preference in plant fragrances and correla-

tion between job satisfaction and preference in plant fragrances, post-traumatic stress symptoms, emotional intelligence, and job stress; multiple regression analysis for the effect of key variables such as preference in plant fragrances on job satisfaction; and frequency analysis for the risk of post-traumatic stress, percentage of job satisfaction, and sociodemographic characteristics. Cronbach's α was calculated for internal reliability of the measurement tools.

Results and Discussion

Analysis on psychological characteristics of firefighters

Post-traumatic stress symptoms

Those with the scores of post-traumatic stress symptoms lower than 17 points are classified as the normal group, those with 18-24 points as the low-risk group, and those with 25 points or higher as the high-risk group (Eun et al., 2005). The post-traumatic stress levels of firefighters that participated in the survey were normal group 62.4%, low-risk group 18.8%, and high-risk group 18.8% (Table 2). More than 90% of firefighters experienced traumatic events, which is a high percentage (Shin et al., 2015), and 18-51% of them were showing post-traumatic stress symp-

toms according to Lee (2012) and Baek (2014). This supports the result of this study in which the sum of the low-risk group and high-risk group was high at 37.6%. Therefore, in-depth consideration is required for the high risk of post-traumatic stress among firefighters.

Difference in emotional intelligence according to sociodemographic characteristics

As a result of determining the difference in emotional intelligence according to sociodemographic characteristics of firefighters, it was found that the average emotional intelligence of 101 participants was 3.67 ± 5.50 . We also analyzed the four sub-domains such as self-emotion appraisal, other-emotion appraisal, emotion regulation, and emotion utilization according to sociodemographic characteristics. The results showed that emotion utilization was higher among those who graduated graduate school than high school, and higher among those in administration than rescue of the disaster response team with statistical significance (Table 4, 7). However, the results were not statistically significant among groups by age, average monthly income, work position, and marital status (Table 3, 5-6). Considering that emotional intelligence of police officers is 3.38/5 and that of psychiatric nurses is 4.83/5, expression of emotions is more limited in the organizational culture of police officers than that of nurses, which is also closely related to the fact that the atmosphere does not encourage individuals to request for help when they have job or psychological difficulties as reported by Lee and Park (2017). This implies that, as shown in this study, the level of emotional intelligence among firefighters was similarly low as police officers, indicating that the organizational culture of firefighters is as rigid as that of police officers.

Table 2. Post-traumatic stress symptoms of the subjects

	Group	n	Percent (%)
Post-traumatic stress symptoms	Normal	63	62.4
	Low risk	19	18.8
	High risk	19	18.8

PTS score ≤ 17 , $\leq 18-24$ (low), ≥ 25 (high) (N = 101).

Table 3. Differences in emotional intelligence by age of fire-fighters

Variance	20s	30s	40s	50s	F	p
Self-emotional appraisal	3.6 $\pm$ 0.60a	3.73 $\pm$ 0.70a	3.81 $\pm$ 0.64a	3.60 $\pm$ 0.87a	0.457	.713
Other's emotional appraisal	3.70 $\pm$ 0.47a	3.52 $\pm$ 0.53a	3.70 $\pm$ 0.58a	3.48 $\pm$ 0.62a	1.100	.353
Regulation of emotion	3.61 $\pm$ 0.62a	3.60 $\pm$ 0.77a	3.85 $\pm$ 0.67a	3.50 $\pm$ 0.87a	0.826	.483
Use of emotion	3.80 $\pm$ 0.66a	3.78 $\pm$ 0.51a	4.09 $\pm$ 0.73a	3.72 $\pm$ 0.80a	1.212	.310
Total	3.68 $\pm$ 0.40a	3.66 $\pm$ 0.50a	3.87 $\pm$ 0.52a	3.57 $\pm$ 0.69a	1.068	.367

Note. Values are mean $\pm$ standard deviation (N = 101). Mean separation within rows by Tukey's multiple range test, 5% level.

Non-significant at $p > .05$ by one way ANOVA.

Table 4. Differences in emotional intelligence by education background of fire-fighters

Variance	High school	University	Graduate school	F	<i>p</i>
Self-emotional appraisal	3.49 ± 0.89a	3.71 ± 0.66a	4.33 ± 0.58a	2.044	.135
Other's emotional appraisal	3.41 ± 0.60a	3.61 ± 0.53a	3.89 ± 0.84a	1.547	.218
Regulation of emotion	3.46 ± 0.89a	3.65 ± 0.72a	4.00 ± 0.00a	0.893	.413
Use of emotion	3.52 ± 0.81a	3.88 ± 0.62ab	4.56 ± 0.51b	4.309	.016*
Total	3.47 ± 0.68a	3.71 ± 0.50ab	4.19 ± 0.46b	3.039	.052

Note. Values are mean ± standard deviation (N = 101). Mean separation within rows by Tukey's multiple range test, 5% level.

*Significant at $p < .05$ by one way ANOVA.

Table 5. Differences in emotional intelligence by marital status of fire-fighters

Variance	Married	Single	Divorce/bereavement/separation	F	<i>p</i>
Self-emotional appraisal	3.68 ± 0.80a	3.66 ± 0.58a	4.17 ± 0.24a	0.471	.626
Other's emotional appraisal	3.52 ± 0.59a	3.65 ± 0.48a	4.00 ± 0.00a	1.168	.315
Regulation of emotion	3.62 ± 0.78a	3.58 ± 0.72a	4.17 ± 0.24a	0.564	.571
Use of emotion	3.83 ± 0.73a	3.81 ± 0.61a	4.00 ± 0.00a	0.069	.933
Total	3.66 ± 0.62a	3.68 ± 0.42a	4.08 ± 0.12a	0.567	.569

Note. Values are mean ± standard deviation (N = 101). Mean separation within rows by Tukey's multiple range test, 5% level.

Non-significant at $p > .05$ by one way ANOVA.

Table 6. Differences in emotional intelligence by work position of fire-fighters

Variance	Fire-fighter	Senior fire sergeant	Fire sergeant	≥Fire lieutenant	F	<i>p</i>
Self-emotional appraisal	3.69 ± 0.59a	3.82 ± 0.77a	3.53 ± 0.68a	3.70 ± 0.84a	0.461	.710
Other's emotional appraisal	3.67 ± 0.49a	3.51 ± 0.54a	3.54 ± 0.52a	3.54 ± 0.64a	0.422	.738
Regulation of emotion	3.69 ± 0.67a	3.74 ± 0.77a	3.56 ± 0.81a	3.54 ± 0.81a	0.379	.768
Use of emotion	3.85 ± 0.61a	3.79 ± 0.52a	3.88 ± 0.68a	3.79 ± 0.81a	0.094	.963
Total	3.72 ± 0.42a	3.72 ± 0.48a	3.63 ± 0.57a	3.64 ± 0.67a	0.197	.898

Note. Values are mean ± standard deviation (N = 101). Mean separation within rows by Tukey's multiple range test, 5% level.

Non-significant at $p > .05$ by one way ANOVA.

Table 7. Differences in emotional intelligence by work type of fire-fighters

Variance	A	B	C	D	F	<i>p</i>
Self-emotional appraisal	3.64 ± 0.65a	3.36 ± 0.77a	3.58 ± 0.87a	3.87 ± 0.68a	2.122	.102
Other's emotional appraisal	3.49 ± 0.54a	3.51 ± 0.45a	3.47 ± 0.44a	3.72 ± 0.62a	1.380	.254
Regulation of emotion	3.63 ± 0.64a	3.49 ± 0.82a	3.72 ± 0.95a	3.62 ± 0.78a	0.221	.881
Use of emotion	3.68 ± 0.60a	3.56 ± 0.69a	4.00 ± 0.70a	4.01 ± 0.70b	2.692	.050*
Total	3.61 ± 0.51a	3.48 ± 0.54a	3.69 ± 0.64a	3.81 ± 0.55a	1.581	.199

Note. Values are mean ± standard deviation (N = 101). Mean separation within rows by Tukey's multiple range test, 5% level.

A: Fire suppression, B: Rescue, C: First aid, D: Administrations

*Significant at $p < .05$ by one way ANOVA.

Distribution of job satisfaction

As a result of determining the survey items on job satisfaction of firefighters, it was found that there were more than 80% of positive responses such as ‘Strongly agree’ and ‘Agree’ in all three items of job satisfaction. There were only 0-1% of the most negative responses of ‘Strongly disagree’, proving that firefighters had high job satisfaction (Table 8). These results are similar to the report by Jang et al. (2020), who surveyed the job satisfaction distribution of the high-risk occupation firefighters and discovered that there were 70-80% of positive responses in all three items, showing consistency with the distribution of this study in which more than 80% are positive responses about job satisfaction.

Firefighters’ preference in plant fragrances

We had firefighters rate their preference in plant fragrances on a 5-point Likert scale for their agro-healing activities and conducted Tukey's range test for post-hoc test. The results of analysis showed that F-value was 14.256 and the p-value was .001, showing that the respondents

most preferred *Citrus limon* fragrance among the 4 types of plant fragrances, followed by *Citrus sinensis*, *Mentha* spp., and *Lavandula* spp. with statistical significance (Table 9). This is similar to the studies by Kim (2005) and Min et al. (1999) proving that the general public's preference for *Citrus limon* fragrance was highest among 4-10 types of fragrances including *Lavandula* spp., supporting the result of this study. Moreover, there is a higher ratio of men than women due to the nature of the job as firefighters, and the result of this study is also supported by Yu (2019) discovering that men showed highest preference for *Citrus limon* fragrance in the preference survey of plant fragrances.

Distribution of preference in plant fragrances according to sociodemographic characteristics

We examined the distribution of preference in plant fragrances for agro-healing activities of firefighters. As a result of conducting Tukey's post-hoc analysis to verify the difference in fragrance preference by age of firefighters, it was found that the 20s showed higher preference for 4 types of fragrances (*Mentha* spp., *Lavandula* spp., *Citrus*

Table 8. Distribution of job satisfaction of fire-fighters

Evaluation items	Strongly disagree		Disagree		Average		Agree		Strongly agree	
	n	%	n	%	n	%	n	%	n	%
1 ^z	0	0.0	5	5.0	17	16.8	33	32.7	46	45.5
2	0	0.0	2	2.0	17	16.8	34	33.7	48	47.5
3	1	1.0	2	2.0	15	14.9	36	35.6	47	46.5

Note. Dependent variable: job satisfaction. job satisfaction was rated on a 5-point Likert scale (N = 101).

^zJob satisfaction 1 = I believe, it was right choice to become fire-fighter; 2 = I have a pride with the job of fire-fighter; 3 = I have a worth and dignity when work.

Table 9. The fragrance preference of garden plants

Fragrance	N	Mean	SD	Tukey's test $\alpha = 0.05$		F	p
				1	2		
Preference	<i>Lavandula</i> spp.	101	2.87	0.98	a ^z	14.256	.001***
	<i>Mentha</i> spp.	101	3.31	0.98	b		
	<i>Citrus sinensis</i>	101	3.60	0.88	b		
	<i>Citrus limon</i>	101	3.61	0.87	b		

^zMean separation within columns by Tukey's multiple range test, 5% level (N = 101).

Note. Values are mean $\pm$ standard deviation. 1 : Never preference - 5 : Very preference

***Significant at $p < .001$ by one way ANOVA.

limon, *Citrus sinensis*) than the 30s-50s, especially for *Lavandula* spp. with statistical significance ($p < .05$). The 20s and 40s most preferred *Citrus limon* out of 4 types of plant fragrances. The 30s and 50s most preferred *Citrus sinensis*, which is supported by Koh (2014) who conducted a preference survey on essential oil fragrances by age and discovered that the 30s and the 50s or older showed the highest preference for *Citrus sinensis* (Table 10). As a result of examining the fragrance preference of firefighters by education, average monthly income, marital status, and current work type, it was found that those who graduated from graduate school and those with an income of 3,000,000 KRW or lower and 5,010,000 KRW or higher showed high preference for *Citrus limon* and *Citrus si-*

nensis but without statistical significance (Table 11-13, 15). However, the study by Kim (2005) who analyzed the fragrance preference by personality and discovered that all three groups that graduated from high school, college, and graduate school most preferred *Citrus sinensis* was similar to the result of this study in which all three groups showed the highest preference for *Citrus sinensis* in the analysis by education. By work position, the result was not statistically significant, but the preference for *Lavandula* spp. was higher among firefighters than senior fire sergeants, showing statistical significance between the two groups (Table 14). Therefore, the results were statistically significant only by age and work position among sociodemographic characteristics, whereas the results were not statistically sig-

Table 10. Differences in preference of plant fragrance by age of fire-fighter

Variance	20s	30s	40s	50s	F	p
<i>Mentha</i> spp.	3.50 ± 1.06a	3.29 ± 1.04a	3.33 ± 1.03a	3.17 ± 0.83a	0.492	.689
<i>Lavandula</i> spp.	3.27 ± 0.94b	2.52 ± 0.85a	3.11 ± 1.02ab	2.80 ± 1.00ab	3.224	.026*
<i>Citrus limon</i>	3.82 ± 0.80a	3.42 ± 0.81a	3.89 ± 0.83a	3.50 ± 0.97a	1.723	.167
<i>Citrus sinensis</i>	3.77 ± 0.75a	3.55 ± 0.89a	3.33 ± 0.84a	3.70 ± 0.99a	0.988	.402

Note. Values are mean ± standard deviation (N = 101). Mean separation within rows by Tukey's multiple range test, 5% level.

*Significant at $p < .05$ by one way ANOVA.

Table 11. Differences in preference of plant fragrance by education of fire-fighter

Variance	High school	University	Graduate school	F	p
<i>Mentha</i> spp.	3.33 ± 0.73a	3.30 ± 1.00a	3.33 ± 2.08a	0.011	.989
<i>Lavandula</i> spp.	2.95 ± 1.02a	2.84 ± 0.95a	3.00 ± 1.73a	0.126	.882
<i>Citrus limon</i>	3.48 ± 0.98a	3.64 ± 0.86a	4.00 ± 0.00a	0.577	.563
<i>Citrus sinensis</i>	3.48 ± 0.75a	3.64 ± 0.92a	3.67 ± 1.15a	0.275	.761

Note. Values are mean ± standard deviation (N = 101). Mean separation within rows by Tukey's multiple range test, 5% level.

Non-Significant at $p > .05$ by one way ANOVA.

Table 12. Differences in preference of plant fragrance by monthly income of fire-fighter

Variance	≤3,000,000	3,010,000~4,000,000	4,010,000~5,000,000	≥5,010,000	F	p
<i>Mentha</i> spp.	3.52 ± 1.06a	3.23 ± 0.99a	3.32 ± 1.00a	3.06 ± 0.73a	0.967	.411
<i>Lavandula</i> spp.	2.94 ± 1.03a	2.87 ± 0.99a	2.89 ± 0.74a	2.72 ± 1.13a	0.192	.901
<i>Citrus limon</i>	3.76 ± 0.83a	3.52 ± 0.81a	3.53 ± 1.07a	3.61 ± 0.85a	0.486	.693
<i>Citrus sinensis</i>	3.67 ± 0.89a	3.45 ± 0.85a	3.68 ± 0.95a	3.67 ± 0.91a	0.437	.727

Note. Values are mean ± standard deviation (N = 101). Mean separation within rows by Tukey's multiple range test, 5% level.

Non-Significant at $p > .05$ by one way ANOVA.

nificant by education, average monthly income, marital status, and work type. However, most firefighters showed high preference for *Citrus limon* and *Citrus sinensis* over *Mentha* spp. and *Lavandula* spp. Therefore, as a result, firefighters with younger age, lower income, lower position, higher education, and job in administration showed highest preference in plant fragrances.

Emotional response toward 4 types of plant fragrances

As a result of analyzing the emotional responses of firefighters toward 4 types of plant fragrances using 11 pairs of emotional adjectives about plants (Table 16 and Fig. 2), it was found that the *Mentha* spp. treatment group strongly felt 'unique', 'fresh', and 'light', the *Lavandula* spp.

treatment group felt 'unique', 'intellective', and 'calm', and the *Citrus limon* and *Citrus sinensis* treatment group felt 'fresh', 'familiar', 'light', and 'natural'. Min et al. (1999) analyzed the emotional adjectives of smell in a study on the image factor structure of fragrances and reported that the emotional word 'fresh' showed the highest frequency in *Citrus limon* fragrance. Yu (2019), who surveyed emotions toward aromas and found that *Lavandula* spp. fragrance showed the highest frequency of 'warm', and *Citrus limon* fragrance showed the highest frequency of 'fresh', supports the results of this study in which the respondents felt mostly 'calm' toward *Lavandula* spp. and 'fresh' toward *Citrus limon* fragrance.

Table 13. Differences in preference of plant fragrance by marital status of fire-fighter

Variance	Married	Single	Divorce/bereavement/separation	F	p
<i>Mentha</i> spp.	3.22 ± 0.94a	3.47 ± 1.03a	3.00 ± 1.41a	0.848	.431
<i>Lavandula</i> spp.	2.76 ± 0.96a	3.03 ± 1.00a	3.50 ± 0.71a	1.280	.283
<i>Citrus limon</i>	3.52 ± 0.91a	3.75 ± 0.81a	4.00 ± 0.00a	0.971	.382
<i>Citrus sinensis</i>	3.56 ± 0.93a	3.67 ± 0.83a	4.00 ± 0.00a	0.381	.684

Note. Values are mean ± standard deviation (N = 101). Mean separation within rows by Tukey's multiple range test, 5% level. Non-Significant at $p > .05$ by one way ANOVA.

Table 14. Differences in preference of plant fragrance by work position of fire-fighter

Variance	Fire-fighter	Senior fire sergeant	Fire sergeant	≥Fire lieutenant	F	p
<i>Mentha</i> spp.	3.39 ± 1.03a	3.54 ± 1.05a	3.00 ± 1.15a	3.31 ± 0.79a	0.954	.418
<i>Lavandula</i> spp.	3.12 ± 0.96b	2.31 ± 0.75a	2.84 ± 0.83ab	2.86 ± 1.07ab	2.253	.087
<i>Citrus limon</i>	3.76 ± 0.79a	3.46 ± 0.88a	3.47 ± 0.90a	3.61 ± 0.93a	0.588	.624
<i>Citrus sinensis</i>	3.64 ± 0.78a	3.46 ± 0.97a	3.53 ± 0.96a	3.67 ± 0.93a	0.231	.875

Note. Values are mean ± standard deviation (N = 101). Mean separation within rows by Tukey's multiple range test, 5% level. Non-Significant at $p > .05$ by one way ANOVA.

Table 15. Differences in preference of plant fragrance by work type of fire-fighter

Variance	Fire suppression	Rescue	First aid	Administrations	F	p
<i>Mentha</i> spp.	3.29 ± 0.96a	3.07 ± 0.80a	3.25 ± 1.22a	3.44 ± 0.99a	0.540	.656
<i>Lavandula</i> spp.	2.97 ± 0.86a	2.87 ± 1.06a	2.33 ± 0.78a	2.95 ± 1.07a	1.438	.237
<i>Citrus limon</i>	3.57 ± 0.85a	3.47 ± 0.92a	3.42 ± 0.67a	3.77 ± 0.93a	0.783	.506
<i>Citrus sinensis</i>	3.40 ± 0.69a	3.40 ± 0.99a	3.67 ± 0.98a	3.85 ± 0.93a	1.936	.129

Note. Values are mean ± standard deviation (N = 101). Mean separation within rows by Tukey's multiple range test, 5% level. Non-Significant at $p > .05$ by one way ANOVA.

Table 16. The difference of emotional words between the four fragrance of plant

Variance	Treatments (fragrance)				F	p
	<i>Mentha</i> spp.	<i>Lavandula</i> spp.	<i>Citrus limon</i>	<i>Citrus sinensis</i>		
Normal - unique	3.74 ± 0.99b	3.60 ± 1.07b	3.36 ± 1.15ab	3.14 ± 1.23a	5.818	.001***
Modern - antique	2.76 ± 1.18ab	3.14 ± 1.12b	2.69 ± 1.06a	2.94 ± 1.13ab	3.178	.024*
Unpleasant - fresh	3.66 ± 1.23b	3.16 ± 1.15a	3.98 ± 1.11b	3.91 ± 1.23b	9.890	.001***
Passionate - intellectual	3.39 ± 1.05a	3.34 ± 0.98a	3.23 ± 0.96a	3.25 ± 1.10a	0.525	.666
Artificial - natural	2.94 ± 1.25a	3.04 ± 1.23ab	3.46 ± 1.17bc	3.63 ± 1.16c	7.647	.001***
Excited - calm	3.26 ± 1.10a	3.30 ± 1.03a	3.21 ± 1.03a	3.48 ± 1.16a	1.165	.323
Unfamiliar - familiar	3.25 ± 1.30ab	2.96 ± 1.17a	3.67 ± 1.11bc	3.81 ± 1.32c	10.221	.001***
Cool - warm	2.75 ± 1.11a	3.03 ± 1.13ab	2.99 ± 1.14ab	3.37 ± 1.21b	4.905	.002**
Urban - rural	2.88 ± 1.21a	3.06 ± 1.21ab	2.99 ± 1.15ab	3.41 ± 1.18b	3.677	.012*
Pungent - delicate	2.81 ± 1.31a	3.00 ± 1.24a	3.03 ± 1.12a	3.58 ± 1.24b	7.420	.001***
Heavy - light	3.34 ± 1.13b	2.86 ± 1.09a	3.63 ± 1.05b	3.67 ± 1.12b	11.663	.001***

Note. Values are mean ± standard deviation (N = 101). Mean separation within columns by Tukey's multiple range test, 5% level (N = 101).

***, **, * Significant at $p < .05$, $p < .01$, or $p < .001$ by repeated-measures ANOVA.

Fig. 2. The difference of emotional words between the four fragrance of plant.

Correlation between preference in plant fragrances and emotional words

As a result of determining the correlation between firefighters' preference in fragrances and emotional words, it was found that *Mentha* spp. showed high positive correlation of at least .5 with 'unpleasant-fresh', 'unfamiliar-familiar', 'artificial-natural', and 'pungent-delicate', and negative correlation with 'normal - unique'. Moreover, *Citrus*

limon showed positive correlation with 'heavy-light', and *Citrus sinensis* with 'pungent-delicate' (Table 17). When preference in plant fragrances increases, most respondents tend to feel more positive emotions such as 'familiar', 'fresh', 'light', 'delicate', and 'natural', while when preference decreases, they feel a more 'normal' emotion. This is supported by Jang et al. (2014) who analyzed the psychological effect of green offices and discovered that the greater effect of green interior designs leads to more positive emotional words such as soothing and comforting, thereby showing positive correlation, which is consistent with the results of this study that higher preference in plant fragrances may lead to higher positive emotions such as 'familiar', 'fresh', 'light', and 'natural'.

Correlation between key variables and preference in 4 types of plant fragrances among firefighters

Correlation between preference in 4 types of plant fragrances and emotional intelligence

As a result of determining the correlation between preference in 4 types of plant fragrances and emotional intelligence of firefighters, the correlation of preference in 4 types of plant fragrances had a range of .073-.332, and showing positive correlation with preference for *Lavandula* spp. and *Citrus limon*, and positive correlation with *Citrus*

Table 17. Correlation between fragrance preference of garden plants and emotional words

Variance	<i>Mentha</i> spp.	<i>Lavandula</i> spp.	<i>Citrus limon</i>	<i>Citrus sinensis</i>
Normal - unique	-.208*	.121	.000	-.003
Modern - antique	.150	.155	.007	-.053
Unpleasant- fresh	.704**	.030	.046	.088
Passionate - intellective	.186	-.029	-.021	.091
Artificial - natural	.630**	-.015	.080	.006
Excited - calm	.279**	.031	.094	.065
Unfamiliar - familiar	.585**	.033	.103	.156
Cool - warm	.320**	.016	-.090	.123
Urban - rural	.321**	.099	.071	.144
Pungent - delicate	.538**	.083	.023	.237*
Heavy - light	.492**	.184	.224*	.104

*** significant at $p < .05$ or $p < .01$, respectively (N = 101).

Table 18. Correlation between preference of plant fragrance and emotional intelligence of participants

V ^z	A	B	C	D	E	F	G	H	I
A	1								
B	.136	1							
C	.094	.211*	1						
D	.073	.184	.332**	1					
E	-.048	.088	.205*	.197*	1				
F	.014	.231*	.231*	.097	.548**	1			
G	-.088	.182	.108	.070	.639**	.417**	1		
H	.036	.157	.172	.155	.539**	.365**	.686**	1	
I	-.031	.197*	.215*	.161	.851**	.687**	.869**	.813**	1

Note. ^zV: Variance; A: Preference of *Mentha* spp.; B: Preference of *Lavandula* spp. C: Preference of *Citrus limon*; D: Preference of *Citrus sinensis*; E: Self-emotional appraisal F: Other's emotional appraisal; G: Regulation of emotion; H: Use of emotion; I: Emotional intelligence Total

*, **significant at $p < .05$ or $p < .01$, respectively (N = 101).

limon and *Citrus sinensis* (Table 18). The correlation between preference in 4 types of plant fragrances and all of emotional intelligence and sub-factors had a range of .014-.231, and the relevance among the variables was low. Moreover, the correlation between all of emotional intelligence and sub-factors was .365-.869, showing high relevance among variables. There was high positive correlation between preference for *Lavandula* spp. fragrance and other-emotion appraisal, preference for *Citrus limon* fragrance and self-emotion appraisal, other-emotion appraisal, and preference for *Citrus sinensis* fragrance and self-emotion appraisal. Therefore, higher preference for

Lavandula spp. fragrance leads to higher preference for *Citrus limon* fragrance, which leads to higher preference for *Citrus sinensis* fragrance. Moreover, higher preference for *Lavandula* spp., *Citrus limon*, and *Citrus sinensis* also leads to higher other-emotion appraisal and self-emotion appraisal.

Correlation between job satisfaction and preference in plant fragrances, post-traumatic stress symptoms, emotional intelligence, and job stress

As a result of determining the correlation of job satisfaction with preference in plant fragrances, post-traumatic

Table 19. Correlation between job satisfaction, preference of plant fragrance, post-traumatic stress, emotional intelligence and job stress of participants

Variance	A ^z	B	C	D	E
Job satisfaction	1				
Preference of plant fragrance	.215*	1			
Post-traumatic stress symptoms	-.282**	-.217*	1		
Emotional intelligence	.396**	.216*	-.227*	1	
Job stress	-.500**	-.177	.336**	-.435**	1

Note. ^zA: Job satisfaction; B: Preference of plant fragrance; C: Post-traumatic stress symptoms; D: Emotional intelligence; E: Job stress.

*, ** significant at $p < .05$, or $p < .01$, respectively (N = 101).

stress symptoms, emotional intelligence, and job stress of firefighters, the relevance between job satisfaction and preference in plant fragrances was .215, and that between job satisfaction and emotional intelligence was .396, showing positive correlation. However, the relevance between job satisfaction and post-traumatic stress was -.282, and that between job satisfaction and job stress was -.500, showing negative correlation with statistical significance. In particular, job satisfaction and job stress showed highest negative correlation of more than .5 ($p < .01$). Therefore, this implies that higher job satisfaction leads to higher fragrance preference and emotional intelligence, and lower post-traumatic stress and job stress (Table 19). This result is supported by Martin (1996) who claim that inhaling pleasant natural fragrances when stressed out affects the limbic system that is closely related to the direct functions of anger, anxiety, and fear, thereby relieving stress. This supports the positive effect of preference in fragrances and stress when inhaling plant fragrances.

Conclusion

This study surveyed and analyzed 101 male and female firefighters aged 39.71 ± 10.94 to assess their preference in 4 types of plant fragrances as well as emotional words to come up with agro-healing activities for firefighters. The psychological evaluation was conducted by having the respondents rate post-traumatic stress symptoms, emotional intelligence, KOSS-SF, and job satisfaction on a Likert scale. Moreover, the preference in plant fragrances was investigated by soaking the tips of fragrance blotter strips

with 20 μ l of 4 types of organic natural essential oils (*Mentha spp.*, *Lavandula spp.*, *Citrus limon*, *Citrus sinensis*) sold in the market. There was a high percentage (37.6%) of risk groups in post-traumatic stress among firefighters. For the difference in emotional intelligence according to socio-demographic characteristics, emotion utilization was high among those who graduated from graduate school, and high among those in administration ($p < .05$). Moreover, the preference for *Citrus limon* fragrance was highest among 4 types of plant fragrances, followed by *Citrus sinensis*, *Mentha spp.*, and *Lavandula spp.* with statistical significance ($F = 14.256$, $p < .001$). For difference of preference in fragrances according to sociodemographic characteristics, the 20s showed higher preference for 4 types of fragrances than the 30s-50s, especially for *Lavandula spp.* with statistical significance ($p < .05$). As a result of analyzing the emotional responses toward 4 types of fragrances, it was found that the *Mentha spp.* treatment group strongly felt 'unique', 'fresh', and 'light', the *Lavandula spp.* treatment group felt 'unique', 'intellective', and 'calm', and the *Citrus limon* and *Citrus sinensis* treatment group felt 'fresh', 'familiar', 'light', and 'natural'. Moreover, as a result of determining the correlation between preference in fragrances and emotional words, it was found that *Mentha spp.* showed high positive correlation of at least .5 with 'unpleasant-fresh', 'unfamiliar-familiar', 'artificial-natural', and 'pungent-delicate', and negative correlation with 'normal - unique'. Moreover, *Citrus limon* showed positive correlation with 'heavy-light', and *Citrus sinensis* with 'pungent-delicate'. Finally, as a result of determining the correlation of job satisfaction with preference in plant fragrances, post-traumatic stress symptoms, emotional in-

telligence, and job stress, it was found that higher job satisfaction leads to higher fragrance preference and emotional intelligence and lower post-traumatic stress and job stress. Therefore, by using *Citrus limon* fragrance with highest preference or applying adequate fragrances according to age distribution to programs such as gardening or horticultural activities in agro-healing for firefighters at work, or considering the result in which *Citrus limon* fragrance was most preferred by men in this job in which there are more men than women due to the nature of the job, it would be possible to increase the effect of agro-healing programs by applying plant fragrances with high preference according to the characteristics of subjects in agro-healing. Furthermore, higher preference in plant fragrances among firefighters will also increase fresh, natural, and familiar emotions. Setting up gardens using plant fragrances in workplaces that are accessible to firefighters will induce calm, fresh, and natural moods for them.

Therefore, applying plants with fragrances that are highly preferred by firefighters will reduce post-traumatic stress and job stress and increase emotional intelligence, which will improve job satisfaction and relieve stress. Based on the results of this study, the usability of agro-healing activities in the workplaces of firefighters can be increased by applying plant fragrances.

The importance of the role of firefighters and their responsibilities are constantly increasing due to the increase in disaster relief and emergency medical care services due to urbanization, but healing methods or policies for physical and psychological stability of firefighters are not being improved in reality. Therefore, agro-healing activities such as gardening with plant fragrances can reduce negative factors such as post-traumatic stress of firefighters and increase emotional intelligence, thereby having positive effects on agro-healing programs that can improve job satisfaction of firefighters.

The limitations of this study and suggestions for further research are as follows. First, the job characteristics of firefighters are different from the organizational culture of other occupations. Since firefighters are sent to the scenes of accidents in teams, teamwork between seniors and juniors within the organization is directly linked to survival, indicating how important hierarchy is. Therefore, it is neces-

sary to understand the job characteristics, language and culture unique to firefighters and continuously study psychotherapy and healing programs at the organizational level that can lower the stress and increase emotional effects through agro-healing activities suitable for firefighters. However, there is insufficient research on actual intervention programs for them. Second, this study conducted a survey on firefighters in Sunchang and Gimje, thereby lacking representativeness of samples as well as diversity of review. Thus, there are limitations in generalizing the results of this study to the entire population. However, expectations for agro-healing activities are building up nationwide with the Act on the Research, Development and Promotion of Agro-healing passed in March 2020. Thus, the stress relief effect of agro-healing activities on firefighters will have a positive impact on the application of healing programs, and this raises the need to conduct continued research to generalize the results. Furthermore, based on the data and results of this study, we are planning to create a healing garden with plants for field assistant team firefighters in the fire department and apply agro-healing programs to the scenes such as gardening in the workplace.

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