

# Effects of Foot Bath and Spray Application of Peppermint and Grapefruit Essential Oils on Lower Extremity Edema, Pain, and Fatigue

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## 페퍼민트, 그레이프후룻 에센셜 오일을 이용한 족욕 또는 스프레이 적용이 하지부종, 통증 및 피로에 미치는 효과

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**Abstract** Work involving standing or walking for a long time can cause swelling, pain, and fatigue in the lower extremities due to the effect of gravity on the circulation of the body. This study aimed to confirm the effects of aromatherapy essential oils, as a complementary and alternative therapy, on lower extremity edema, pain, and fatigue when applied as a foot bath or spray. The study was conducted after daytime work over two consecutive days on nurses who volunteered at the E University Hospital in D Metropolitan city between 15 August 2018 and 11 October 2018. This randomized controlled study. The foot bath group received a foot bath in 9 L of water containing 0.5 ml of essential oil blended with grapefruit and peppermint in a 1:1 ratio. The spray group received the same solution in 3% dilution in the form of a spray. Edema was assessed by measuring calf and ankle circumference, while pain and fatigue were evaluated using a numerical rating scale. Data were analyzed by ANOVA and repeated-measures ANOVA. The calf circumference in the foot bath and spray groups significantly reduced compared to that in the control group ( $F = 14.053, p < .001$ ) after the interventions. Lower extremity pain ( $F = 42.497, p < .001$ ) and fatigue ( $F = 20.641, p < .001$ ) also significantly reduced in the foot bath and spray groups compared to those in the control group after the interventions. Foot bath is recommended to relieve swelling and pain in the lower extremities, and aroma spray is highly recommended considering the ease of application.

**Key Words** : Aromatherapy, Randomized controlled trial, Grapefruit, Peppermint, Complementary and Alternative Therapy

**요약** 오랫동안 서 있거나 걷는 등의 작업 후에 흔히 증력으로 인한 체내순환이 영향을 받아 하지의 부종, 통증, 피로 등이 발생할 수 있다. 본 연구는 보완대체요법으로 아로마테라피 에센셜 오일을 이용하여 족욕 또는 스프레이로 적용하였을 때 하지부종 및 하지 통증, 피로에 미치는 효과를 확인하기 위한 연구이다. 본 연구는 무작위통제연구이며, 연구 참여자는 2018년 8월 15일부터 2018년 10월 11일까지 D광역시 소재 E 대학교병원에서 연구 참여자 모집공고에 자원한 간호사 78 명을 대상으로 동질성을 유지하기 위한 낮은 근무를 하는 간호사로 하였다. 실험 중재는 그레이프후룻과 페퍼민트를 1:1로 블렌딩한 에센셜 오일을 0.5ml 넣은 9L의 물에 족욕을 하거나 3%로 희석하여 분사하는 스프레이 방법을 적용하였다. 자료는 ANOVA, Repeated Measures ANOVA로 분석하였다. 아로마 테라피 족욕군과 스프레이군의 종아리 둘레가 대조군에 비해 유의하게 감소하였다( $F = 14.053, p < .001$ ). 하지 통증 ( $F = 42.497, p < .001$ )과 피로 ( $F = 20.641, p < .001$ )도 실험 중재 후 아로마테라피 족욕군과 스프레이군에서 대조군보다 유의하게 감소하였다. 하지의 부종과 통증을 완화하기 위해 족욕을 권장하며, 적용 수월성을 고려할 때 아로마 스프레이를 적극 권장한다.

**주제어** : 아로마테라피, 무작위 대조 실험, 그레이프루트, 페퍼민트, 보완대체요법

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Received June 29, 2021

Accepted November 20, 2021

Revised October 27, 2021

Published November 28, 2021

## 1. Introduction

After long hours of work involving standing or walking, gravity can affect the circulation in the body, causing swelling, pain, and fatigue in the lower extremities [1]. Among nurses, a high prevalence of musculo skeletal disorders was observed in the knees, calves, ankles, and feet of the lower extremities [2]. The work of nurses requires them to stand for extended periods, in tense environments; thus, they often complain of leg pain and fatigue [3]. Long-term edema and pain in the lower extremities can cause vascular diseases, such as varicose veins [4]. Nurses might also experience pain in the back or headaches due to insufficient circulation [5]. The veins of the lower extremities are in the system of superficial and deep veins, which are connected by perforating veins. Venous blood return is achieved by the pressure difference between arteries and veins caused by the central pumping action of the heart, by muscle pumps such as calf muscle contraction, and by intravenous valves to prevent reflux. Therefore, it is important to intervene by preventing the accumulation of extracellular fluid in the tissues of the lower extremities, and to strengthen the function of valves inside the dilated blood vessels through massage to relieve the swelling and pain in the lower extremities [1].

Interventional studies have evaluated the efficacy of self-foot reflexology [6], elastic compression stockings [7], taping [8], foot mats [9], foot bath therapy [10], and ankle pump exercise [11] in relieving lower extremity swelling and pain and physical fatigue in nurses. Among these, foot bath therapy is a simple bathing method that promotes blood circulation and metabolism to relax muscles and relieve stress in a non-invasive way [12].

Aromatherapy, a complementary and alternative therapy, is a compound word made

up of aroma, which means natural fragrance, and therapy, and uses essential oils extracted from flowers, seeds, roots, resins, and leaves [13]. It promotes blood and lymph circulation, relieves tension and pain, inhibits microbial growth, and activates the immune system [14]. Essential oils are easily absorbed into the bloodstream through the skin and the mucous membrane of the respiratory tract, affecting the overall circulation, and are safe and convenient to use [15]. They are used for a variety of purposes, such as inhalation, bathing, and massage, and various studies have proven their efficacy. Of the essential oils, grapefruit stabilizes the central nervous system and aids in blood circulation, while peppermint is excellent for muscle pain and mental fatigue [14].

In this study, we investigated the effect of blended grapefruit and peppermint oil as a foot bath and spray on lower extremity edema and pain in nurses. Foot bath therapy is a health management method that promotes blood circulation throughout the body, helping to recover from fatigue and improving body functions [16]. In a previous randomized crossover-controlled study of the effects of lavender oil foot baths, a significantly increased blood flow was attributed to the foot baths [17]. Aromatherapy spray is a method of spraying essential oil diluted to 2 to 5% with distilled water, and can be used without space restrictions. Although the spray method is simple and can be applied anytime, anywhere, there was currently no research using aromatherapy spray applied to edema. Because nurses play a key role in terms of health in hospitals and homes, it is desirable to induce them to manage their own health rather than receive passive management [18].

The present study attempted to confirm the effect of an aromatherapy foot bath and spray

using blended grapefruit and peppermint oil on lower extremity edema, pain, and fatigue and evaluate the efficacy of aroma spray as an easily-applicable edema relief intervention method.

## 2. Methods

### 2.1 Design

This study was a randomized controlled trial to compare the effects of aromatherapy foot bath and aromatherapy spray on lower extremity edema, pain, and fatigue, as shown in Fig. 1.

### 2.2 Participants

#### 2.2.1 Selection of Study Participants

The study was conducted after daytime work over two consecutive days on nurses who volunteered at the E University Hospital in D Metropolitan city between 15 August 2018 and 11 October 2018.

The inclusion criteria for study participants were ward nurses between the ages of 20 and 40 who worked during the day, understood the purpose of the study, and voluntarily agreed to participate in the study. Exclusion criteria were those with open wounds or skin diseases on the lower extremities, those with conditions that contraindicate aromatherapy essential oils, pregnancy, and hypertension. Since there may be a significant correlation between age and fatigue [19], age and work characteristics were limited to ensure the homogeneity of participants, and those with hypertension were excluded because essential oils could affect blood pressure [20].

#### 2.2.2 Sample Size Calculation

The sample size was calculated by substituting the alpha value, power, and effect size using the G\*power 3.1.9 program [21]. The effect size of this study was calculated by partial eta squared, similar to a previous study [10].

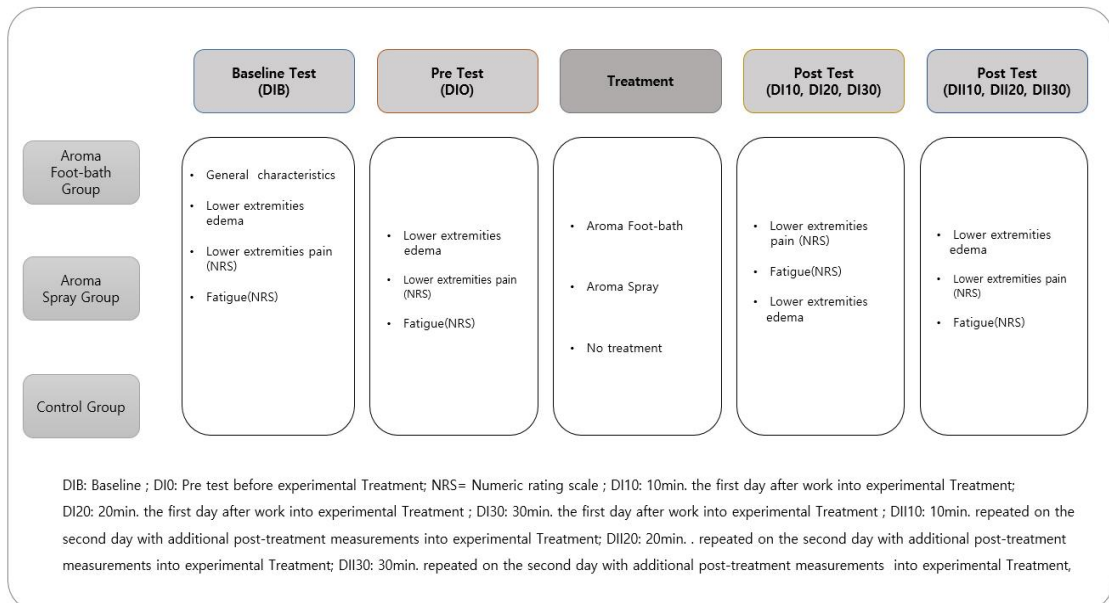


Fig. 1. Study design

The sample size was calculated for repeated measures ANOVA by inserting the following values: significance level alpha value: 0.05; power 1- $\beta$ : 0.95; number of replicates: 4; number of groups: 3; correlation between repeated measurements: 0.20, and effect size: 0.25. As a result of the calculation, the suggested total sample size was 69. In this study, considering the 2-day intervention, the dropout rate was 15%, and a total of 80 participants were selected. Two participants dropped out during the experiment for personal reasons. Therefore, as shown in Fig. 2, a total of 78 people participated in this study.

### 2.2.3 Assignment of Participants and Blinding

After the announcement of the recruitment of research participants in the Department of Nursing at E university hospital, located in D city, nurses who met the criteria were recruited. Participants were assigned to the aromatherapy foot bath group, aromatherapy spray group, or the control group using random number generation in Microsoft Excel 2010. Of the 78 final participants, 26 were assigned to the aromatherapy foot bath group, 26 to the

aromatherapy spray group, and 26 to the control group. Experiments on the control group were performed in a separate interview room to prevent contamination of the intervention groups Fig. 2. Although the participants were not informed about their particular groups after group assignment, full blinding was not possible due to the nature of the intervention.

### 2.3 Ethical Considerations

The research proposal was approved by the institutional review board (EMC 2018-05-012-002). We obtained permission from the nursing department and the nurses voluntarily participated in the study through in-hospital recruitment. Before receiving consent to participate, the participants were provided with an information guide with sufficient detail, including the purpose of the study, experimental procedures, possibility of participation and withdrawal, side effects, and compensation. For the collected data, each participant was assigned a unique number for privacy and confidentiality.

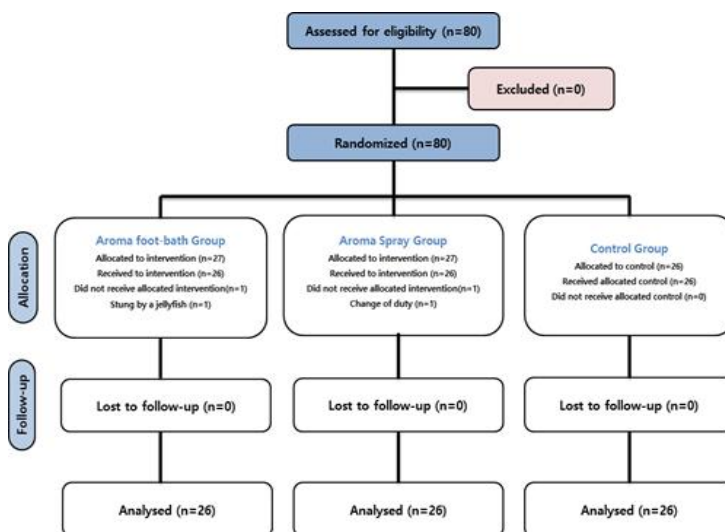


Fig. 2. Flow diagram

After collecting data from the participants, a small gift was given in return for participation in the study.

## 2.4 Experimental Treatments

### 2.4.1 Environmental setting for the experiment

The experimental environment was a room with a well-ventilated window, and an adjustable angle chair was placed to provide a comfortable environment.

### 2.4.2 Experimental Preparation

#### 2.4.2.1 Preparation of aromatherapy essential oil

Aromatherapy essential oils were selected and blended with oils that are effective in treating edema, pain, fatigue [20] after consultation with an international aromatherapy specialist. The aromatherapy essential oils used in the intervention were grapefruit, which was reported to be effective in edema by stimulating lymph. Peppermint, distilled from leaves, is known to be effective in relieving fatigue and muscle pain. The aromatherapy essential oil was prepared by blending grapefruit and peppermint oils at 1:1 ratio and adding it to the same amount of solubilizer.

#### 2.4.2.2 Aromatherapy foot bath

A foot bath machine capable of maintaining temperature (SHF-M850, Korea) was used. The aromatherapy essential oil was stored in a shaded container at room temperature before use.

#### 2.4.2.3 Aromatherapy spray

A small sprayer was used to apply the aromatherapy spray. For the spray, the prepared aromatherapy essential oil was diluted with 94 cc of distilled water. The sprays were kept refrigerated.

### 2.4.3 intervention

#### 2.4.3.1 Aromatherapy foot bath group

A quantity of 0.5 cc of the blended oil was added to 9 L of water at 40°C and added to the foot bath machine. The feet were immersed in the water to a depth of about 20 cm for 30 min.

#### 2.4.3.2 Aromatherapy spray group

After blending grapefruit and peppermint oils at 1:1 ratio and adding the same amount of solubilizer, a quantity of 6 cc of the prepared blended oil was added to 94 cc of distilled water to reach the final concentration of 3%. The participants sat in chairs with a backrest for 30 min while the oil was sprayed on their lower limbs thrice at 10min intervals. The sprayer was shaken before every use. The amount sprayed on every use was 4 cc, and the total amount for three sprays was 12 cc.

#### 2.4.3.3 Control group

The participants sat in chairs with a backrest for 30 min without any intervention.

## 2.5 Measurements

### 2.5.1 Lower Extremities Edema

To measure the change in the edema in the lower extremities, a glass fiber tape measure was used as a surface measurement method. In the upright posture, the circumference of the thickest part of the calf and the circumference of the upper and lower part of the ankle were measured to the first decimal place in cm.

### 2.5.2 Lower Extremities Pain

The subjective pain in the lower extremities after work was scored using the numeric rating scale (NRS). The participants marked their subjective pain level on a straight line with a scale of 0 to 10, where a higher score meant more severe pain.

### 2.5.3 Fatigue

Fatigue was scored using the NRS. The participants marked their subjective fatigue level on a straight line with a scale of 0 to 10, where a higher score meant more fatigue.

### 2.6 Data Collection Procedure

The data collected at each time point were the participants' calf circumference (in cm), upper and lower ankle circumference (in cm), lower extremity pain (NRS), and fatigue (NRS). On the first day of data collection, the

dependent variable was measured before the start of the task (DIB), and questionnaires were used to obtain general information. Dependent variables were measured as soon as participants arrived at the laboratory on the first day after work (DI0) and then 10, 20, and 30 min (DI10, DI20, and DI30, respectively) after treatment initiation. The same measurements were repeated on the second day with the post-treatment measurements at 10, 20, and 30 min designated as DII10, DII20, and DII30, respectively.

**Table 1. Homogeneity Test of General Characteristics among The Three Groups (N=78)**

Variables	Category	Aroma Foot-bath (n=26)	Aroma spray (n=26)	Cont (n=26)	F or $\chi^2$	p
		M±SD or n(%)	M±SD or n(%)	M±SD or n(%)		
Sex	Male	0( 0.0%)	0( 0.0%)	2( 7.7%)	2.733	0.325*
	Female	26(100%)	26(100%)	24(92.3%)		
		<b>N(%)</b>	<b>N(%)</b>	<b>N(%)</b>		
Age (year)	21~24	6(23)	5(19)	8(31)	1.136	0.327
	25~29	11(42)	18(69)	13(50)		
	30~34	8(31)	2(8)	5(19)		
	35~39	1(4)	1(4)	0(0)		
Total work career (month)	~24	6(23)	5(19)	10(38)	1.381	0.258
	25~60	7(27)	11(42)	7(27)		
	61~120	10(38)	9(35)	7(27)		
	121~	3(16)	1(4)	2(8)		
Lower extremities edema (cm) D <sub>IB</sub>	Calf	33.55±2.50	34.52±3.42	34.16±3.24	0.660	0.520
	Above the ankle	20.47±1.19	20.68±1.34	20.46±1.24		
	Below the ankle	23.74±1.21	23.84±1.32	24.01±1.91		
Lower extremities pain (NRS) D <sub>IB</sub>		2.35±1.90	2.58±2.04	2.04±1.78	0.521	0.569
Stress (NRS) D <sub>IB</sub>		3.69±1.20	4.27±2.05	4.00±2.51	0.448	0.641
Fatigue (NRS) D <sub>IB</sub>		4.00±2.15	4.54±1.96	4.00±2.13	0.577	0.564
Stress after normal work day (NRS)		7.35±1.02	6.92±1.44	6.85±1.49	1.062	0.351
Fatigue levels after normal work day (NRS)		7.92±1.123	7.31±.88	7.54±1.27	2.052	0.136
Lower extremities edema after normal work day (NRS)		7.35±1.16	6.77±1.73	6.92±1.98	0.843	0.434
Lower extremities pain after normal work day (NRS)		6.77±1.93	6.81±1.65	6.88±1.66	0.029	0.971

Aroma Foot-Bath= Aromatherapy Foot Bath; Aroma Spray = Aroma Essential Oil Spray; NRS = Numeric Rating Scale, Cont = Control Group; M±SD = Mean±Standard Deviation

## 2.7 Data Analysis

The collected data were analyzed using IBM SPSS Statistics 24.0. General characteristics of the study participants were analyzed by mean and standard deviation, and in real number and percentage, and the homogeneity test was analyzed by  $X^2$  test, Fisher's exact test, and ANOVA. ANOVA was used to test the difference according to the change in time for lower extremity edema, pain, and fatigue before and after the intervention in all the three groups.

## 3. Results

### 3.1 Verification of the Participants' Homogeneity

#### 3.1.1 Homogeneity Test for General Characteristics

There were a total of 78 participants, with 26 participants in each of the three groups.

We found no statistically significant differences in sex, age, total work experience, lower extremity edema, pain, and fatigue after a normal work day, confirming that the three groups were homogeneous as shown in Table 1.

**Table 2. Comparison of Calf, Above and Below the Ankle Circumference among the Three Groups (N=78)**

Calf (cm)	Aroma Foot-bath (n=26)	Aroma spray (n=26)	Cont (n=26)	F	p	Repeated Measure ANOVA	
	M±SD	M±SD	M±SD			Source	F(P)
D <sub>I B</sub>	33.55±2.50	34.52±3.42	34.16±3.24	0.660	0.520	Time	105.041 <sup>b</sup> ( $<.001$ )
D <sub>I 0</sub>	34.49±2.58	35.31±3.50	34.99±3.12	0.467	0.628	Group	.702(.499)
D <sub>I 30</sub>	33.76±2.73 <sup>a</sup>	34.77±3.41 <sup>a</sup>	35.00±2.94 <sup>b</sup>	0.481*	$<0.001^*$	Group*Time	9.384b( $<.001$ )
D <sub>II B</sub>	33.63±2.65	34.58±3.40	34.41±3.13	0.702	0.499	Time	80.065 <sup>b</sup> ( $<.001$ )
D <sub>II 0</sub>	34.45±2.54	35.24±3.51	35.01±3.05	0.457	0.635	Group	.670(.515)
D <sub>II 30</sub>	33.79±2.63 <sup>a</sup>	34.66±3.46 <sup>a</sup>	34.95±3.12 <sup>b</sup>	14.053*	$<0.001^*$	Group*Time	7.416 <sup>b</sup> ( $<.001$ )
							Time 60.374 <sup>b</sup> ( $<.001$ ) Group .689(.505) G*T 5.237 <sup>b</sup> ( $<.001$ )
Above the ankle(cm)	Aroma Foot-bath (n=26)	Aroma spray (n=26)	Cont (n=26)	F	p	Repeated Measure ANOVA	
	M±SD	M±SD	M±SD			Source	F(P)
D <sub>I B</sub>	20.47±1.19	20.68±1.34	20.46±1.24	0.238	0.789	Time	54.890 <sup>b</sup> ( $<.001$ )
D <sub>I 0</sub>	21.08±1.03	21.38±1.45	21.04±1.43	0.512	0.601	Group	.150(.861)
D <sub>I 30</sub>	20.91±1.23 <sup>a</sup>	20.97±1.39 <sup>b</sup>	21.11±1.43 <sup>a</sup>	3.634*	0.031*	Group*Time	2.041 <sup>b</sup> (.092)
D <sub>II B</sub>	20.49±1.18	20.76±1.34	20.46±1.18	0.490	0.615	Time	68.404 <sup>b</sup> ( $<.001$ )
D <sub>II 0</sub>	21.10±1.22	21.40±1.36	20.76±1.19	1.718	0.186	Group	.675(.512)
D <sub>II 30</sub>	21.03±1.19 <sup>a</sup>	21.06±1.37 <sup>b</sup>	20.83±1.22 <sup>a</sup>	5.223*	0.008*	Group*Time	5.021 <sup>b</sup> (.001)
							Time 44.969 <sup>b</sup> ( $<.001$ ) Group 326(.723) G*T 3.234 <sup>b</sup> (.001)
Below the ankle(cm)	Aroma Foot-bath (n=26)	Aroma spray (n=26)	Cont (n=26)	F	p	Repeated Measure ANOVA	
	M±SD	M±SD	M±SD			Source	F(P)
D <sub>I B</sub>	23.74±1.21	23.84±1.32	24.01±1.91	0.213	0.809	Time	20.188 <sup>b</sup> ( $<.001$ )
D <sub>I 0</sub>	24.21±1.26	24.59±1.39	24.30±1.73	0.468	0.628	Group	.202(.817)
D <sub>I 30</sub>	24.19±1.22 <sup>a</sup>	23.84±1.25 <sup>b</sup>	24.53±1.63 <sup>a</sup>	19.409*	$<0.001^*$	Group*Time	8.683 <sup>b</sup> ( $<.001$ )
D <sub>II B</sub>	23.64±1.28	23.82±1.51	23.80±1.33	0.139	0.870	Time	32.530 <sup>b</sup> ( $<.001$ )
D <sub>II 0</sub>	24.17±1.39	24.49±1.41	24.28±1.40	0.347	0.708	Group	.105(.901)
D <sub>II 30</sub>	24.16±1.24 <sup>a</sup>	23.92±1.31 <sup>b</sup>	24.39±1.62 <sup>a</sup>	8.345*	0.001*	Group*Time	4.135 <sup>b</sup> (.003)
							Time 19.356 <sup>b</sup> ( $<.001$ ) Group .153(.859) G*T 4.379 <sup>b</sup> ( $<.001$ )

Means for each group with different superscripts (a,b) indicate a significant difference (Bonferroni test ;  $p<.05$ )

Aroma Foot-bath=Aromatherapy foot bath; Aroma spray = Aroma essential oil spray; Cont =Control group CM=centimeter; M±SD =Mean±standard Deviation; G\*T : Group\*Time \* : ANCOVA; D<sub>I B</sub> =1<sup>st</sup> day Baseline; D<sub>I 0</sub> = 1<sup>st</sup> day into work; D<sub>I 30</sub> = 1<sup>st</sup> 30min into experimental treatment D<sub>II B</sub> = 2<sup>nd</sup> day Baseline; D<sub>II 0</sub> =2<sup>nd</sup> day into work; D<sub>II 30</sub> =2<sup>nd</sup> 30min into experimental treatment

Table 3. Comparison of subjective Lower Extremities Pain and Fatigue among the Three Groups (N=78)

Lower extremities pain(NRS)	Aroma Foot-bath (n=26)	Aroma spray (n=26)	Cont (n=26)	F	P	Repeated Measure ANOVA	
	M±SD	M±SD	M±SD			Source	F(P)
D <sub>I B</sub>	2.35±1.90	2.58±2.04	2.04±1.78	0.521	0.596	Time	81.904 <sup>b</sup> ( $<.001$ )
D <sub>I 0</sub>	5.92±2.13	5.96±1.93	6.12±1.82	0.070	0.933		
D <sub>I 10</sub>	4.65±1.94	4.96±1.34	5.27±1.80	0.839	0.436	Group	3.011(.055) Time
D <sub>I 20</sub>	3.42±1.58	3.62±1.50	4.96±1.78	6.939	0.002		53.436 <sup>b</sup> ( $<.001$ )
D <sub>I 30</sub>	2.08±1.16 <sup>a</sup>	2.27±1.31 <sup>a</sup>	4.65±1.98 <sup>b</sup>	29.719*	$<.001$ *	Group*Time	6.220 <sup>b</sup> ( $<.001$ ) Group
D <sub>II B</sub>	3.54±2.18	3.73±2.15	3.73±1.87	0.075	0.928	Time	66.737 <sup>b</sup> ( $<.001$ ) 4.479(.015)
D <sub>II 0</sub>	5.69±2.26	5.88±2.07	6.08±1.79	0.230	0.795		
D <sub>II 10</sub>	4.54±1.99	4.81±1.83	5.73±2.01	2.689	0.075	Group	4.523(.014) G*T
D <sub>II 20</sub>	3.50±1.90	3.54±1.75	5.15±2.09	6.287	0.003		3.850 <sup>b</sup> ( $<.001$ )
D <sub>II 30</sub>	2.88±1.51 <sup>a</sup>	3.73±2.26 <sup>a</sup>	6.08±2.23 <sup>b</sup>	42.497*	$<.001$ *	Group*Time	6.670 <sup>b</sup> ( $<.001$ )

Fatigue (NRS)	Aroma Foot-bath (n=26)	Aroma spray (n=26)	Cont (n=26)	F	p	Repeated Measure ANOVA	
	M±SD	M±SD	M±SD			Source	F(P)
D <sub>I B</sub>	4.00±2.15	4.54±1.96	4.00±2.14	0.577	0.564	Time	45.719 <sup>b</sup> ( $<.001$ )
D <sub>I 0</sub>	6.96±2.03	6.62±1.65	7.00±1.47	0.389	0.679		
D <sub>I 10</sub>	5.35±1.62	5.85±1.46	6.77±1.58	5.588	0.005	Group	6.754(.002) Time
D <sub>I 20</sub>	4.15±1.71	4.81±1.55	6.62±1.70	15.421	$<.001$		26.575 <sup>b</sup> ( $<.001$ )
D <sub>I 30</sub>	3.04±1.87 <sup>a</sup>	3.96±1.82 <sup>a</sup>	6.42±1.94 <sup>b</sup>	27.120*	$<.001$ *	Group*Time	6.794 <sup>b</sup> ( $<.001$ ) Group
D <sub>II B</sub>	4.88±2.22	5.27±2.01	5.12±1.93	0.231	0.794	Time	44.986 <sup>b</sup> ( $<.001$ ) 7.695(.001)
D <sub>II 0</sub>	6.92±1.90	6.73±1.37	7.08±1.55	0.298	0.743		
D <sub>II 10</sub>	5.38±1.79	5.77±1.75	6.62±1.60	3.499	0.035	Group	5.545(.006) G*T
D <sub>II 20</sub>	4.31±1.59	4.85±1.87	6.42±1.92	9.688	$<.001$		3.486 <sup>b</sup> ( $<.001$ )
D <sub>II 30</sub>	2.88±1.51 <sup>a</sup>	3.73±2.26 <sup>a</sup>	6.08±2.23 <sup>b</sup>	20.641*	$<.001$ *	Group*Time	5.143 <sup>b</sup> ( $<.001$ )

Means for each group with different superscripts (a,b) indicate a significant difference (Bonferroni test ;  $p<.05$ )

Aroma Foot-bath=Aromatherapy foot bath; Aroma spray = Aroma essential oil spray; Cont =Control group CM=centimeter; M±SD =Mean±standard Deviation; G\*T : Group\*Time \* : ANCOVA; D<sub>I B</sub> =1<sup>st</sup> day Baseline; D<sub>I 0</sub> = 1<sup>st</sup> day into work; D<sub>I 30</sub> =1<sup>st</sup> 30min into experimental treatment D<sub>II B</sub> = 2<sup>nd</sup> day Baseline; D<sub>II 0</sub> =2<sup>nd</sup> day into work; D<sub>II 30</sub> :=2<sup>nd</sup> 30min into experimental treatment

### 3.1.2 Homogeneity Test for Dependent Variables

The calf circumference after work was 34.49 cm in the aromatherapy foot bath group, 35.31 cm in the aromatherapy spray group, and 34.99 cm in the control group. After work, the circumferences above and below the ankle were 21.08 cm and 24.2cm, respectively, in the aromatherapy foot bath group, 21.38 cm and 24.59 cm, respectively, in the aromatherapy spray group, and 21.04 cm and 24.30 cm, respectively, in the control group. Subjective lower extremity pain scores for the foot bath group, the spray group and the control group

were 5.92, 5.96, and 6.12, respectively. There was no statistically significant difference in edema and pain of the lower extremities among the three groups, confirming homogeneity of the dependent variable as shown in Table 2, 3.

### 3.2 Effect of Aromatherapy Foot Bath and Spray on Lower Extremities Edema, Pain, and Fatigue

On day 1, the calf circumference of the aromatherapy foot bath group was 33.55 cm before work, 34.39 cm before intervention, and 33.76 cm after 30 min of intervention. On day 2, the calf circumference was 33.63 cm before



work, 34.45 cm before treatment, and 33.79 cm at 30 min after intervention. The values of the aromatherapy spray group were 34.52 cm, 35.31 cm, and 34.77 cm, respectively, on the first day, 34.58 cm, 35.24 cm, and 34.66 cm, respectively, on the second day; the values of the control group were 34.16, 34.99 cm, 35.00 cm, respectively, on the first day and 34.41 cm, 35.01 cm, and 34.95 cm, respectively, on the second day as shown in Table 2.

Analysis of these results showed no significant differences among the three groups in the calf circumference before and after work on both days. However, there was a significant difference in the calf circumference of the three groups 30 min into the intervention on day 1 ( $F=20.481$ ,  $p<0.001$ ) and day 2 ( $F=14.053$ ,  $p<0.001$ ), as shown in Table 2.

Similarly, there was no significant difference in ankle circumference between the three groups before work and before intervention, but after 30 min of intervention, the circumference above and below the ankle on day 1 ( $F = 3.634$ ,  $p = 0.031$ ), ( $F = 19.409$ ,  $p < 0.001$ ), day 2 ( $F = 5.223$ ,  $p = 0.008$ ), ( $F = 8.345$ ,  $p = 0.001$ ) were significantly different between the three groups, respectively as shown in Table 2. Also, there was no significant difference in lower extremity pain and fatigue between the three groups before work and before intervention. However, there was a significant difference in lower extremity pain on day 1 ( $F = 29.719$ ,  $p < 0.001$ ) and day 2 ( $F = 42.497$ ,  $p < 0.001$ ) at 30 min of intervention. Fatigue was also significantly different between the three groups on the first day ( $F=27.120$ ,  $p<0.001$ ) and the second day ( $F=20.641$ ,  $p<0.001$ ) as shown in Table 3.

#### 4. Discussion

This study was attempted to confirm the effect on lower extremity edema, pain, and

fatigue when applied as a foot bath or spray using grapefruit and peppermint oil as complementary and alternative therapies. Intervention was given for 2 days and the effect was analyzed. We used a blended oil formulation with a 1:1 ratio of grapefruit oil and peppermint oil. Grapefruit oil is extracted from the peels of grapefruit and its traditional actions are diuretic, antiseptic, disinfectant [20]. The therapeutic effects of peppermint essential oil include vasoconstriction, antiseptic, anticonvulsant, and analgesic effects [21]. The blended oil was mixed distilled water before use. When distilled water is used as a solvent, there is no irritation and it can be sprayed directly, but since essential oils are not soluble in water, it should be shaken before use [22]. In this study, a solubilizer was used to make oil mix well with water. The temperature of the water used for the foot bath was around 40°C; this stimulates the parasympathetic nerves of the body, providing mental stability and relaxing the muscles [23].

In the present study, there were no significant differences in the edema of the lower extremities among the three groups before the intervention, but there was a significant difference after the intervention. Lower extremities edema significantly decreased in the aromatherapy foot bath group and the aromatherapy spray group compared with the control group. This is similar to the results of a randomized controlled study that tested the effect of aromatherapy foot baths in women [17] wherein the blood flow significantly increased and parasympathetic nerve activity increased after 10 min of instituting the aroma foot bath. It can be considered that the edema decreased due to the effect of promoting blood circulation and preventing water retention in the lower extremities. There has been no study

confirming the effect of aromatherapy spray on lower extremity edema, but herein, aromatherapy spray showed the same effect as the aromatherapy foot bath. Based on these results, aromatherapy foot bath and aromatherapy spray have similar effects in relieving lower extremity edema.

Ko et al. [24] reported that nurses who had to stand for long periods of time complained of weakness and pain in their legs, unable to stand upright, and often complained of burning feet. In this study, it was also found that the degree of lower extremity pain increased significantly before and immediately after work. Lower extremity pain and fatigue significantly decreased in the aromatherapy foot bath and spray groups compared to those in the control group. As the baseline pain and fatigue in the aromatherapy spray group was similar to those in the aromatherapy foot bath group, it can be said that the former also has a significant effect on pain relief and fatigue decrease.

Although grapefruit essential oil is effective in reducing obesity and water retention, and consequently, in reducing body fat and edema, and peppermint has a pain-relieving effect [20], studies on edema reduction and pain relief effects are lacking. In a study on body fat, grapefruit effectively suppressed adipogenesis in rats [25]. In this study, the foot bath of grapefruit and peppermint was effective for edema and lower extremity pain, so this blended essential oil can be considered effective for edema relief. Foot baths are known to improve blood circulation and thus can reduce edema and provide pain relief. However, aroma spray was also found to be effective in relieving swelling and pain this study. Aroma spray can be applied by itself, has no side effects, is safe and economical, so it can be effectively used as an intervention for lower

extremity edema and pain relief, indicating that it is an effective intervention method for occupational workers who work standing up. Therefore, it can be considered an alternative to the aromatherapy foot bath, especially considering its ease of application.

## 5. Conclusion

In conclusion, the aromatherapy foot bath was effective in alleviating lower extremity edema and pain in participants after work, and the aromatherapy spray showed similar effects. Therefore, foot baths with aromatherapy are recommended to alleviate work-related lower extremity edema and pain and considering the ease in application, aromatherapy sprays are strongly recommended.

The limitation of this study was that the aromatherapy foot bath group, the aromatherapy spray group, and the control group could not be completely concealed due to the nature of the aromatherapy intervention. The participant's workload, which could be a confusing variable, could not be completely controlled. In addition, the inability to study the skin condition of the lower extremities, mobility and function, quality of life, and degree of stress adaptation remains a limitation. Therefore, it is considered that studies including these measurement variables are necessary for future studies.

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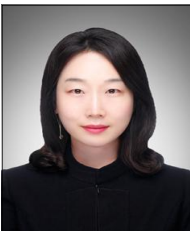
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