**Citrus aurantium** Aroma for Anxiety in Patients with Acute Coronary Syndrome: A Double-Blind Placebo-Controlled Trial

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**Abstract**

**Objective:** This study evaluated the antianxiety effect of *Citrus aurantium* aroma (neroli oil) inhalation on patients with acute coronary syndrome (ACS).

**Design:** A double-blind, placebo-controlled randomized trial.

**Setting/Location:** This study was conducted in the Coronary Care Unit of Torfeh Hospital in Tehran, Iran, from September 2017 to February 2018.

**Subjects:** A total of 140 hospitalized ACS patients (mean age = 56.72 ± 11.38 years)

**Interventions:** Eligible patients were randomly assigned to citrus aroma and placebo groups to receive inhalation aromatherapy 2 days after hospitalization. Citrus aroma was 30% essential oil of *Citrus aurantium* L. flowers in paraffin, which was administrated three times a day. The placebo group received paraffin similarly.

**Outcome measures:** The rate of anxiety was measured at baseline and after intervention using the State–Trait Anxiety Inventory.

**Results:** At baseline, citrus aroma and placebo groups were similar in demographic characteristics as well as anxiety scores. After intervention, mean anxiety scores in the two groups become significantly different; the scores were 34.66 ± 9.6 and 42.36 ± 6.4 for citrus aroma and placebo groups, respectively (p < 0.0001). No side effect was observed.

**Conclusions:** According to the current findings, aromatherapy with *Citrus aurantium* L. aroma (neroli oil) may be a safe and efficient intervention and can be considered an easy and applicable method to reduce anxiety in patients with ACS.

**Keywords:** acute coronary syndrome, neroli oil, anxiety, *Citrus aurantium* L., aromatherapy, traditional Persian medicine

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**Introduction**

Acute coronary syndrome (ACS), as acute myocardial ischemia, can lead to myocardial infarction (MI). ACS includes various conditions such as unstable angina, non-ST-segment elevation MI, and ST-segment elevation MI.1 In the United States and European countries, ACS is the most common cause of death in cardiovascular diseases. In Iran, despite progress in using modern therapeutic methods, the ACS mortality rate shows an increasing trend.2,3 Patients with ACS experience various environmental, physical, and emotional tensions during hospitalization in the cardiac care unit (CCU),4,5 leading to high rates of anxiety increasing mortality in these patients.6–8

Therefore, prevention and treatment of anxiety in patients hospitalized in the CCU are an absolute necessity, otherwise it may lead to increase in extension and persistence of the disease, as well as risk of ischemia, second stroke, ventricular

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tachycardia, and fibrillation. Benzodiazepines are one of the most frequently used antianxiety drugs, but occurrence of physical dependence and side effects such as anterograde amnesia and an increased risk of falling in elderly people are some adverse effects of these drugs.

Therefore, there is a considerable tendency to use complementary and alternative medicine (CAM) to manage anxiety. Aromatherapy is one of the CAM branches with a growing trend, particularly in nursing care. Furthermore, in traditional Persian medicine (TPM), there is a considerable emphasis on using aromatic herbal drugs to relieve emotional disorders, including anxiety. The traditional medicine in Iran (TPM) dates back to about 10,000 years, which generally emphasizes prevention and nonpharmacological therapies in the first step. It has provided many novel and effective therapies that are approved by new studies.  

Citrus aurantium L. (CA) belongs to the Rutaceae family and its leaves, flowers, fruits peels, and seeds have various therapeutic uses. Additionally, it was indicated that consumption of CA and oxazepam tablets had equal efficacy on preoperative anxiety reduction of anxiety during labor, disorders, including anxiety. The usefulness for preoperative anxiety and scores more than 20 according to the State–Trait Anxiety Inventory (STAI). The exclusion criteria were lacking willingness to continue participation in the study, occurrence of any serious cardiologic conditions such as cardiac shock and cardiopulmonary arrest, patient clearance, and transfer to another place.

**Herbal drug preparation**

CA aroma in this study was the essential oil of *Citrus aurantium* L. flowers. *Citrus aurantium* L. is the accepted name of a species in the genus Citrus and Rutaceae family (www.theplantlist.org). The citrus flowers were obtained from a garden in Chalus, Iran, and the essential oil was prepared by hydrodistillation and characterized by gas chromatography–mass spectrometry (GC/MS) analysis. CA aroma and placebo were prepared in the Traditional Medicine Clinical Trial Research Center of Shahed University. The CA aroma used for aromatherapy contained 30% essential oil of CA flowers in liquid paraffin, and the placebo was food-grade liquid paraffin (manufactured by Mehrabani Co.). Both the essence and placebo were poured and packaged in similar dark glass containers. A label showing the specific private code as well as instructions for use was attached on every container.

**Study design**

This double-blind, placebo-controlled, randomized clinical trial was conducted in the CCU ward of Torfeh Hospital in Tehran, Iran, from September 2017 to February 2018. The study followed guidelines of the Declaration of Helsinki for humans. All study participants provided written informed consent, and the study protocol was approved by the Medical Ethics Committee of Shahed University (IR. Shahed. REC. 1395. 172). In addition, the trial was registered in the Iranian Registry of Clinical Trials (IRCT2017011331919N1).

**Randomization and blinding**

Eligible patients were selected using the convenience sampling method and allocated to CA aroma and placebo groups through block randomization. The CA aroma and placebo had similar packages; they were randomly coded from 1 to 140. The codes were kept confidential by an independent pharmacist until the end of the study and data analysis. Aromatherapy was performed by a nurse who was uninformed about the study, and outcomes were recorded by another blind observer. The researcher and analyzer were blinded to allocation.

**Intervention**

The patients were examined under the supervision of a cardiologist and the eligible ones were included. After receiving a complete explanation of how the study was conducted, the participants signed the consent. Their demographic data were assessed and documented in related forms. Then, they were divided into two groups for receiving the standardized CA aroma or placebo. To perform intervention, first, a drop of CA aroma or placebo, prepared for the same patient with a special bar code, was rubbed over the nondominant hand’s forearm and screened for 2 h. If the patient was not allergic, he/she entered the study. At the time of administration,
1.5 cc of the content inside the glass was applied to a small piece of gauze (2×2-cm square shape, same for every patient) and attached to the collar of the patient’s clothes, and he/she was asked to breathe normally for 20 min.

**Herbal drug assay**

Results of the GC/MS analysis of citrus essential oil are shown in Table 1. As shown, the major components are linalyl acetate (65.86%), linalool (13.66%), and geraniol (7.51%). In addition, the range of compounds of the Neroli oil according to the European Pharmacopoeia standard is presented in a different column for comparison.

**Data collection instruments**

Demographic and clinical data, including age, gender, marital status, education, history of hospitalization, and history of smoking, were collected in a self-reported form before intervention. The patients’ anxiety was measured

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**Table 1. Gas Chromatography–Mass Spectrometry Analysis of *Citrus aurantium* Essential Oil in Comparison with Pharmaceutical Standards**

<table>
<thead>
<tr>
<th>No.</th>
<th>RT</th>
<th>%</th>
<th>Components</th>
<th>KI</th>
<th>Ph Eur limits (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14.64</td>
<td>0.35</td>
<td>Myrcene</td>
<td>994</td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>16.80</td>
<td>0.14</td>
<td>Limonene</td>
<td>1035</td>
<td>9.0%–18%</td>
</tr>
<tr>
<td>3</td>
<td>17.67</td>
<td>0.20</td>
<td>Z-β-Ocimene</td>
<td>1052</td>
<td>N/A</td>
</tr>
<tr>
<td>4</td>
<td>20.62</td>
<td>13.66</td>
<td>Linalool</td>
<td>1109</td>
<td>28.0%–44.0%</td>
</tr>
<tr>
<td>5</td>
<td>21.63</td>
<td>1.09</td>
<td>Phenylethyl alcohol</td>
<td>1129</td>
<td>N/A</td>
</tr>
<tr>
<td>6</td>
<td>22.34</td>
<td>0.13</td>
<td>dihydro-Linalool</td>
<td>1143</td>
<td>N/A</td>
</tr>
<tr>
<td>7</td>
<td>25.59</td>
<td>0.83</td>
<td>α-Terpineol</td>
<td>1209</td>
<td>2.0%–5.5%</td>
</tr>
<tr>
<td>8</td>
<td>25.76</td>
<td>0.2</td>
<td>γ-Terpineol</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>9</td>
<td>27.85</td>
<td>65.86</td>
<td>Linalyl acetate</td>
<td>1257</td>
<td>2.0%–15.0%</td>
</tr>
<tr>
<td>10</td>
<td>28.07</td>
<td>7.51</td>
<td>cis-Geraniol</td>
<td>1262</td>
<td>N/A</td>
</tr>
<tr>
<td>11</td>
<td>32.7</td>
<td>0.6</td>
<td>Benzoic acid, 2-amino-, methyl ester</td>
<td>1273</td>
<td>N/A</td>
</tr>
<tr>
<td>12</td>
<td>32.82</td>
<td>0.81</td>
<td>Neryl acetate</td>
<td>1366</td>
<td>Maximum 2.5%</td>
</tr>
<tr>
<td>13</td>
<td>33.70</td>
<td>0.90</td>
<td>Geranyl acetate</td>
<td>1386</td>
<td>1.0%–5.0%</td>
</tr>
<tr>
<td>14</td>
<td>—</td>
<td>—</td>
<td>β-Pinene</td>
<td></td>
<td>7.0%–17%</td>
</tr>
<tr>
<td>15</td>
<td>—</td>
<td>—</td>
<td>trans-Nerolidol</td>
<td></td>
<td>1.0%–5.0%</td>
</tr>
<tr>
<td>16</td>
<td>—</td>
<td>—</td>
<td>Methyl anthranilate</td>
<td></td>
<td>0.1%–1%</td>
</tr>
<tr>
<td>17</td>
<td>—</td>
<td>—</td>
<td>(E,E)-farnesol</td>
<td></td>
<td>0.8%–4.0%</td>
</tr>
<tr>
<td>92.28</td>
<td></td>
<td></td>
<td>Total identified</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

KI, Kovats Index; RT, retention time.
before and after the intervention using the STAI. This instrument is a self-report psychological inventory based on a 4-point Likert scale consisting of 40 questions. It measures two types of anxiety disorders: anxiety about an event and anxiety level as a personal characteristic, namely state and trait anxiety, respectively. The current study used the first 20 questions related to state anxiety.²² A reliable and valid Persian version of STAI was used in the current study.⁴³

**Statistical analysis**

The study data were analyzed using SPSS 18.0 (SPSS, Inc., Chicago, IL). The Kolmogorov–Smirnov test was used to evaluate the normality of continuous variables. Continuous variables with normal distribution were analyzed using the t-test. Categorical variables were analyzed using the chi-square test and Fisher’s exact test. p-Values <0.05 were considered significant.

**Results**

**Participants**

All the study participants (n = 140) completed the trial. Figure 1 presents the flow diagram.

**Evaluation of groups’ homogeneity**

Table 2 summarizes the patient demographic data. Obviously, there are no significant differences between the patients in both groups regarding age and other character-

**Table 2. Demographic and Clinical Characteristics of Participants**

<table>
<thead>
<tr>
<th>Variables</th>
<th>CA aroma group (n = 70)</th>
<th>Placebo group (n = 70)</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>56.76 (11.39)</td>
<td>56.69 (11.37)</td>
<td>0.970</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>41 (58.6)</td>
<td>33 (47.1)</td>
<td>0.236</td>
</tr>
<tr>
<td>Male</td>
<td>29 (41.4)</td>
<td>37 (52.9)</td>
<td></td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>3 (4.3)</td>
<td>4 (5.7)</td>
<td>0.240</td>
</tr>
<tr>
<td>Married</td>
<td>59 (84.3)</td>
<td>51 (72.9)</td>
<td></td>
</tr>
<tr>
<td>Widow</td>
<td>8 (11.4)</td>
<td>15 (21.4)</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illiterate</td>
<td>5 (7.1)</td>
<td>7 (10)</td>
<td>0.780</td>
</tr>
<tr>
<td>Primary</td>
<td>40 (57.1)</td>
<td>40 (57.1)</td>
<td></td>
</tr>
<tr>
<td>Diploma</td>
<td>19 (27.1)</td>
<td>15 (21.0)</td>
<td></td>
</tr>
<tr>
<td>University</td>
<td>6 (8.6)</td>
<td>8 (11.4)</td>
<td></td>
</tr>
<tr>
<td>History of hospitalization</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>40 (57.1)</td>
<td>38 (54.3)</td>
<td>0.865</td>
</tr>
<tr>
<td>No</td>
<td>30 (42.9)</td>
<td>32 (45.7)</td>
<td></td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>16 (22.9)</td>
<td>17 (24.3)</td>
<td>0.97</td>
</tr>
<tr>
<td>No</td>
<td>54 (77.1)</td>
<td>53 (75.7)</td>
<td></td>
</tr>
</tbody>
</table>

*Statistical significance, p < 0.05.

**Table 3. Comparison of Anxiety Scores Between Groups Before and After the Intervention**

<table>
<thead>
<tr>
<th>Anxiety score*</th>
<th>Group</th>
<th>n</th>
<th>mean</th>
<th>SD</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>CA aroma group</td>
<td>70</td>
<td>42.77</td>
<td>9.72</td>
<td>0.093</td>
</tr>
<tr>
<td>intervention</td>
<td>Placebo group</td>
<td>70</td>
<td>45.13</td>
<td>6.40</td>
<td></td>
</tr>
<tr>
<td>After</td>
<td>CA aroma group</td>
<td>70</td>
<td>34.66</td>
<td>9.68</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>intervention</td>
<td>Placebo group</td>
<td>70</td>
<td>42.36</td>
<td>6.49</td>
<td></td>
</tr>
</tbody>
</table>

*Statistical significance, p < 0.05.

Effect of inhalation aromatherapy on anxiety. As Table 3 shows, the mean anxiety scores before intervention were 42.77 ± 9.72 in the CA aroma group and 45.13 ± 6.40 in the placebo group. There was no significant difference between the groups according to the independent t-test (p = 0.093). The mean anxiety scores after intervention were 34.66 ± 9.68 in the CA aroma group and 42.36 ± 6.49 in the placebo group, and there was a significant difference between them (p < 0.0001). The effect size was calculated as 0.8. No serious side effect was reported during the study.

**Discussion**

This study aimed to compare anxiolytic effects of CA aroma inhalation and placebo on ACS patients. The results showed a significant reduction of anxiety scores in the CA aroma group compared with the placebo group after intervention. In line with the global approach to CAM, there is a growing trend in using inhalation aromatherapy as an easy and safe intervention to reduce anxiety in patients admitted to intensive care units.⁴⁴ According to TPM, aromatic herbal drugs had tonic and exhilarant effects on the heart. Therefore, they can not only improve psychological disorders such as anxiety and depression but also treat some conditions such as palpitation, as shown by a recent trial.⁴⁵ The influence of odorants on heart activity has also been shown in recent studies.⁴⁶

Furthermore, the efficacy of aromatherapy on patients admitted to the CCU has been shown in several studies: anxiolytic effect of geranium (Pelargonium graveolens L’Hér; Family: Geraniaceae) essence on patients with acute MI,⁴⁶ essential oils of Damask rose flower (Rosa damascena Miller; Family: Rosaceae) and English lavender flowering tops (Lavandula angustifolia Miller, syn. Lavandula officinalis Chaix; Family: Lamiaceae) on patients undergoing open heart surgery,⁴⁷ and mixed essence of the blossom of the bitter orange tree (Citrus aurantium) subsp. amara or Bigaradia Family: Rutaceae), chamomile (Matricaria chamomilla L., syn. Matricaria recutita Family: Asteraceae), and English lavender flowering tops (Lavandula angustifolia Miller, syn. Lavandula officinalis Chaix; Family: Lamiaceae) for sleep quality of patients with ACS,⁴⁸ are some examples.

The results of the studies by Najafi et al.⁴⁹ and Nematollahi et al.⁴⁰ are in line with our results; they indicated that
aromatherapy reduced anxiety in patients admitted to the critical care unit. However, the essential oil used in the two studies mentioned was of lavender and, in the latter, it was a combination (containing lavender, chamomile, and neroli), and in the case of the current study, it was neroli essence alone. To suggest a possible mechanism, the anti-inflammatory effect may be a common important mechanism. Recent studies have indicated that inflammation has an effect on behavior,\textsuperscript{54,55} and extensive researches in this field have shown a bidirectional relationship between anxiety disorder and inflammation markers.\textsuperscript{56}

Therefore, investigation into the effectiveness of anti-inflammatory treatments for the psychiatric disorder is a key topic for recent studies.\textsuperscript{54,55} Regarding strong anti-inflammatory effects of CA essential oil and inhibition of production of nitric oxide, interleukin-6, tumor necrosis factor-\(\alpha\), and interleukin-1\(\beta\), as well as their gene expression level,\textsuperscript{57} the hypothesis can be developed that CA essential oil exerts anti-nociceptive effects mainly through its anti-inflammatory mechanism. The GC-MS analysis of CA essential oil used in the current study indicated the following main constituents: linalyl acetate (65.8\%), linalool (13.66\%), and geraniol (7.51\%); however, another study conducted in Greece reported the following main constituents of CA essential oil: linalool (29.14\%), \(\beta\)-pinene (19.08\%), and limonene (12.04\%).\textsuperscript{57}

In addition, analysis of the flower essential oil obtained from CA cultivated in Tunisia reported the following main constituents: limonene (27.5\%), (E)-nerolidol (17.5\%), \(\alpha\)-terpinene (14\%), and \(\alpha\)-terpinyl acetate (11.7\%).\textsuperscript{22} There is no doubt that changing the location or condition of the plant’s growth will affect its essential components. Despite the lack of sufficient studies to determine the extent to which clinical changes in the components of essential oils can change its clinical effects, this should be considered in clinical studies using essential oils. Although this study has limitations such as the inability to reconcile the drug with the placebo, results suggest that the beneficial effects of aromatherapy with essential oil are considerable.

**Conclusion**

As the current study results indicate the effectiveness of inhalation aromatherapy with CA flower essential oil, it may be beneficial as an anxiolytic treatment for ACS patients. Considering the high prevalence and importance of anxiety among these patients and necessity of its management, this simple and efficient nursing intervention may be a valuable and important solution. Thus, it may be recommended that aromatherapy with CA essential oil be included in the nursing program of CCU patients.

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**Author Disclosure Statement**

No competing financial interests exist.

**References**


17. Alijaniha F, Ghaffari F, Naseri M. Smelling drugs application, in the prevention and treatment of disease, from the


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