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Research Article

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Evaluation of the inhalation of lavender oil on physiological and psychological effects: A pilot study

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ABSTRACT

Stress has a proven negative impact on health. Recently, researchers have been interested in finding natural based solutions that can assist in managing stress levels. Essential oils (EOs) are natural phytochemicals that are powerful in their health care benefits. Lavender EO is popular in its role of relieving stress. Thus, the main purpose of this study is to investigate the relaxation effect of inhaling lavender essential oil on the physiological and psychological parameters using smart technology. The study was conducted on university students, in which a homogenous group of healthy students were selected to participate in this study. The students were exposed to olfactory stimulation, which involves spraying the air "as a control" and the lavender essential oil using an air diffuser. The physiological measurements were taken by smart tools that measure the heart rate (HR), heart rate variability (HRV), and oxygen level (OL). Conventional medical instruments were used to measure the heart rate (HR), and blood pressure (BP). The psychological measurements were recorded by surveying the participants using the online web application tool "Google Forms" by answering mood state questionnaires, which took place after the experimental and control conditions. Results showed that aromatherapy inhaling lavender EO has a significant effect on the overall measured physiological parameters (reduction in the HR and BP, and increase in the HRV), and enhancement on the overall psychological parameters; thus minimizing the overall stress levels among the university students.

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INTRODUCTION

Essential oils (EOs) are naturally concentrated phytochemicals extracted exclusively from specific plant species. Such phytochemicals are rich in active compounds that have health-care and therapeutic benefits (Raut & Karuppayil, 2014). Historically, traditional herbal practices have supported the health-care benefits of such herbal extracts. Bedouins have used aromatic plants for various health improvement and healing properties. For example, *Mentha spicata* (Spearmint) has been used in traditional practices as a flavoring, digestive, gastro-stimulant, and carminative agent (Shahin, 2018). In addition to folk practices, the use of EOs has recently gained global popularity, which is always needed to provide research-based evidence for the usage effectiveness of such EOs extracts (Shahin *et al.*, 2021).

Nowadays, our life conditions have become more stressful due to multiple physiological and psychological stressors, especially after the COVID-19 pandemic (Ajaj & Shahin, 2021; Ajaj *et al.*, 2023). The modern lifestyle associated with long working hours and high workloads have all led to fatigue, exhaustion and burnout (Shahin *et al.*, 2021). Similarly, students experience varying levels of stress throughout their academic journey, particularly during assessment periods (Paz-Cortés *et al.*, 2024). Consequently, it is useful to investigate the effectiveness of healthy lifestyle routines, such as aromatherapy, on health and wellness parameters (Kim & Song, 2022).

Lavender (*Lavandula angustifolia*, Family: Lamiaceae) is an aromatic plant well-known for its aromatherapy benefits. Lavender EO extracted from the flowers is widely used to reduce anxiety, improve mood and enhance overall health conditions (Cavanagh & Wilkinson, 2002; Salamati *et al.*, 2014, 2017).

According to previous studies, aromatherapy by lavender EO is reported to have a controversial biological activity, in which some studies support it is effectiveness in reducing physiological parameters (Grunebaum *et al.*, 2011; Baldwin & Chea, 2018; Kim & Song, 2022), while other fewer studies reported having no significant activity (Babulka *et al.*, 2017).

Consequently, the main objective of this pilot study was two-fold: first to investigate the effectiveness of utilizing lavender EO on relaxation physiological parameters in a healthy homogenous group of university students. Tested Physiological parameters include heart rate (HR), heart rate variability (HRV), oxygen level (OL), and blood pressure (BP). Second, the effectiveness of lavender EO inhalation on the psychological parameters, including anxiety, and state mood level was tested through an e-survey on the same studied group.

MATERIALS AND METHODS

The study was conducted on Umm Al Quwain University students, in which a homogenous group of healthy students were selected to participate in this study (18 students; Aged: 20 to 30 years; Males: 55.56% and females: 44.44%). Participants' details are shown in Table 1.

The ethics committee (4/2/15/3/2024) granted ethics approval on 1 March 2024. All the participated students were given a brief description of the research project and the tested parameters. After acceptance of participation, the selected students were exposed to olfactory stimulation, which involved spraying the air "as a control" and the lavender essential oil using air diffuser. The experiment's room dimensions were 1.9 × 2.3 m^2, in which participants inhaled each of the tested treatments for a period of 5 minutes (Spray volume: 80mL/H, Water tank capacity: 700 mL). The amount of added lavender EO was according to the air diffuser's instructions of use.

The experiment was conducted during a stressful period prior to the end of the Fall 2022 semester (During November, afternoon times). All participants confirmed their ability to smell having cold-free symptoms.

Physiological Parameters

The physiological measurements were taken by smart tools that measure the heart rate (HR), heart rate variability (HRV), and oxygen level (OL). Smart tools included a fingertip pulse oximeter and the smart mobile application (Heartify). A conventional medical instrument, using the upper arm blood pressure monitor (Beurer, Germany), was used to measure the heart rate (HR), and blood pressure (BP).

Psychological Parameters

Students' responses, which measure the general psychological measurements, were collected after the control and after inhaling lavender EO using a structured pre-tested questionnaire through the web application tool (Google Forms). Students' attitudes about lavender EO inhaling and their associated impact were measured using a 5-point Likert scale, in which higher scores indicated higher level of anxiety/depression/fatigue. To subjectively evaluate the psychological effects of olfactory stimulation, participants answered questionnaires after the control and the experimental conditions.

Table 1: Participants' details

	Mean±Standard Deviation (SD)		
Parameter	Total (n=18)	Male (n=10)	Female (n=8)
Age (years)	24.61±3.90	25.00±4.10	24.13±3.59
Height (cm)	164.78±4.18	165.5±4.72	163.88±3.14
Weight (kg)	69.50±4.76	70.90±4.23	67.75±4.82
Body mass index (kg/m^2)	25.58±1.10	25.88±0.99	25.20±1.12

Statistical Analysis

A statistical package for social sciences (SPSS) version 25.0 for Windows was used to analyze the data. Raw collected data was reviewed to remove outliers. Descriptive statistics were presented as mean, standard deviations, and standard error bars. A one-way analysis of variance (ANOVA) was performed to compare the means between tested treatments. Statistical significance was set at $p<0.05$.

RESULTS AND DISCUSSIONS

Analysis of variance showed a significant difference (at $p<0.05$) for the influence of lavender EO inhalation on lavender EO on the HR (Figure 1) measured either by the smart fingertip pulse oximeter (at $p<0.03$) or by the conventional blood pressure monitor (at $p<0.02$). Lavender EO inhalation reduced significantly the HR levels, in which the HR decreased significantly from approximately 85 beats per minute to around 78 beats per minute when measured with a blood pressure monitor. Similarly, HR reduced from about 80 beats per minute to 76 beats per minute when measured with a fingertip pulse oximeter.

Also, results showed an enhancement in the influence of lavender EO inhalation on the HRV (Figure 2) measured by the smart mobile application (Heartify). Inhaling lavender EO enhanced significantly the HRV from approximately 55 ms to around 62 ms when measured with the smart mobile application (Heartify). However, the OL measured by the fingertip pulse oximeter didn't show any difference between the tested treatments. The results showed an average OL of (97±1.36)% in the control group, which did not change significantly after inhaling lavender essential oil, remaining at an average of (97.25±1.24)%.

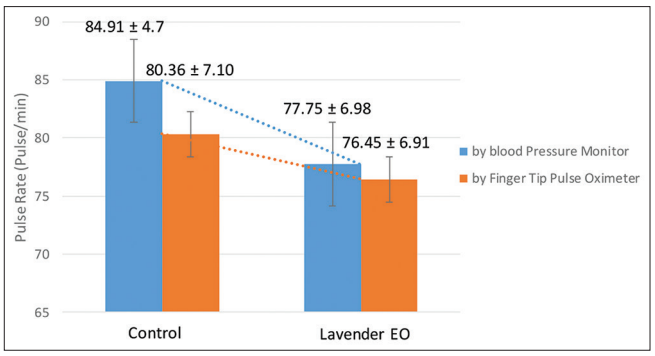

Figure 1: Impact of lavender EO on HR using conventional and smart blood pressure monitor

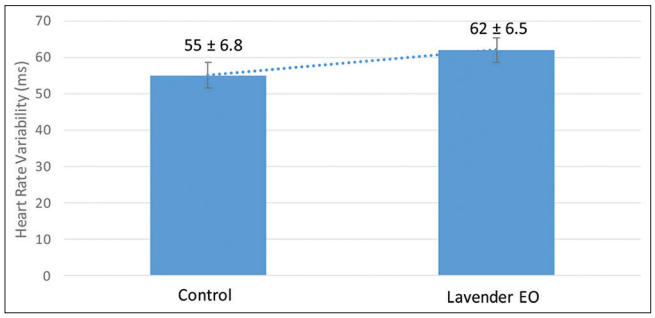

Figure 2: Impact of lavender EO on HRV measured by the smart mobile application (Heartify)

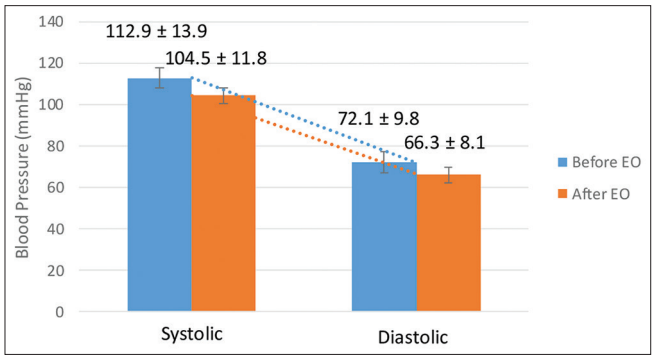

Figure 3: Impact of lavender EO on BP

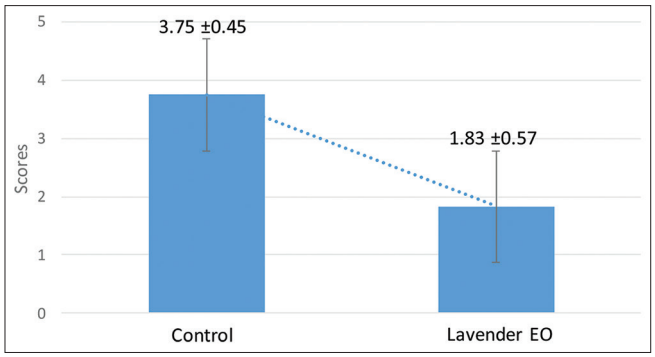

Figure 4: Impact of lavender EO on anxiety level

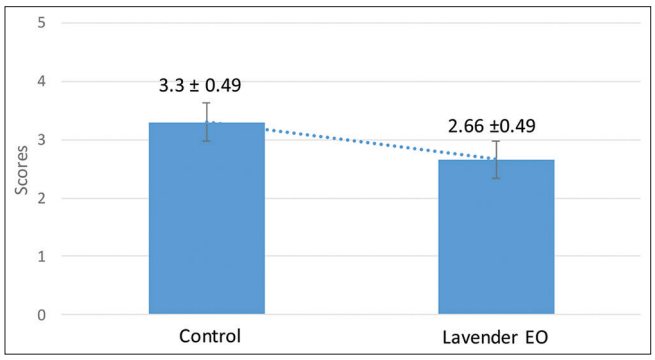

Figure 5: Impact of lavender EO on depression level

The study showed a significant difference in the BP levels (at $p<0.001$) after inhaling lavender EO (Figure 3). The systolic and diastolic blood pressure had been significantly reduced after

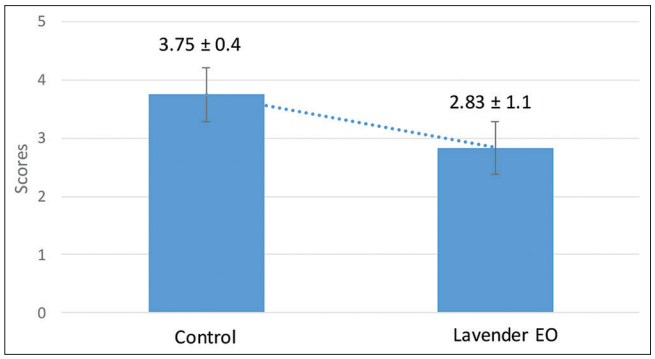

Figure 6: Impact of lavender EO on fatigue level

lavender EO inhalation. , from approximately (Systolic: 113 mmHg, Diastolic: 72 mmHg) to around (Systolic: 105 mmHg, Diastolic: 66 mmHg).

According to the study, lavender EO inhalation reduced significantly (at $p<0.05$) the tested psychological parameters, including anxiety (Figure 4), depression (Figure 5), and fatigue (Figure 6). Results showed that the average anxiety score (3.7±0.45) was reduced significantly to (1.83±0.57) by lavender EO inhaling. A similar trend was found for depression, which reduced significantly from the average score (3.3±0.49) to (2.66±0.49). As well as, fatigue scores were recorded to reduce significantly from the average score (3.75±0.04) to (2.83±1.1).

Based on the study, this research showed that inhaling lavender EO causes a significant reduction in HR and BP and a significant enhancement in the HRV. Similar results were reported by other research groups (Baldwin & Chea, 2018). According to Dong and Jacob (2016), aromatherapy by Lavender EO was found to decrease the rise in BP induced during hand-grip exercise, and thus has been recommended as a useful stress control tool. The reduction in physiological activity is due to the possible relaxation effect of the stimulus on overall cardiovascular activity (Ziyaeifard *et al.*, 2017; Sebastian & Kear, 2022). The enhancement in the HRV due to EO inhalation was similarly reported by (Kim & Song, 2022). HRV describes the variation in time intervals between consecutive heartbeats, in which higher HRV is often associated with better cardiovascular fitness and resilience to stress. It is worth mentioning that, in Germany lavender EO is a licenced treatment for anxiety (Kasper *et al.*, 2020). The justification is based on it is possible activity as an agonist at 5HT-1A receptors, which are involved in anxiety (Dong & Jacob, 2016), as well as, due to its similar activity to Fir (*Abies holophyla*) EO in decreasing the sympathetic nervous activity (Kim & Song, 2022). In this work, the OL didn't show any significant difference while inhaling the lavender EO, which may need further inhalation time to lead to a significant change. It is needed to establish standard methodologies that researchers can rely on for conducting aromatherapy research works.

Regarding the psychological parameters, this research showed that inhaling lavender EO causes a significant reduction in tested psychological parameters including anxiety, depression, and fatigue, and thus enhances the students' positive mood and

mental health. Similar results were reported by Kim and Song (2022), in which inhalation of fir (*Abies holophyla*) EO was found to reduce the overall stress levels of all participants. The possible justification could be due to the significant reduction in sympathetic activity, and thus reduction in the heart rate level along with other cardiovascular activities. Representing relaxation feelings and comfortability reflected in the reduced anxiety, depression, and fatigue. Similar results and justifications were mentioned by Ikei *et al.* (2016), Ziyaeifard *et al.* (2017), Sebastian and Kear (2022), Vora *et al.* (2024) and Chung *et al.* (2024). A study conducted by Seubert *et al.* (2009) reported the gender impact on the recorded results. Thus, future research should be carried out to investigate such factor on the reported psychological parameters.

CONCLUSION

Lavender EO inhalation has a significant influence on the relaxation physiological parameters tested among the university students, including HR, HRV, and BP. While, OL didn't show any significant difference among the tested students. Besides, lavender EO inhalation has a significant effect on the relaxation psychological parameters tested among university students, including anxiety, depression and fatigue. Consequently, lavender EO can be used as an effective tool to reduce anxiety, relieve stress and enhance the overall mental health of university students and any stressed community member.

Future research done on a larger scale using lavender EO and other aromatherapy EOs (e.g., lemon, peppermint) in conjunctive with other treatments (e.g., music, light) are recommended. The research findings should be communicated to the public community through social media, to educate students and any possibly stressed community members about the need to introduce aromatherapy in their today's life routine, which supports a healthy lifestyle with mitigated stress levels.

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