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Original Article

Inhalation effect of lychee-scented candles on stress and sleep quality among adults and the elderly: a pilot randomized controlled study

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Abstract. [Purpose] This pilot study aims to investigate the effects of inhaling lychee-scented candles on stress and sleep quality among adults and the elderly. [Participants and Methods] Thirty participants were randomly assigned to either the control (n=15) or experimental (n=15) groups. The experimental group inhaled the scent from the lychee soy wax candle prior to going to bed for four weeks (20 minutes/session, three days/week). Perceived stress was assessed using the Suanprung Stress Test-20 (SPST-20), while sleep quality was assessed using the Thai-Pittsburgh Sleep Quality Index (Thai-PSQI). All outcomes were determined at the baseline two weeks to four weeks after scent inhalation. [Results] The results indicated significant differences in sleep quality between the two groups. The experimental group showed a statistically significant improvement in sleep quality compared to the control group. Although, there was no difference between groups, the experimental group presented significant decrease in stress as time passed whereas the opposite trend was seen for the control group. [Conclusion] This preliminary study suggests that the inhalation of lychee soy wax candles over a four-week period improved sleep quality in adults and the elderly but had no effect on reducing stress.

Key words: Aromatherapy, Stress, Sleep quality

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INTRODUCTION

Stress results from a person's perception that they do not have the resources to cope with a perceived situation. Stress occurs when an individual is faced with a situation considered to be overwhelming and one they cannot cope with[1)]. While stress is a typical reaction to daily pressures or demands, prolonged stress can result in mental health disorders and physical ailments[2)].

Sleep is an essential physiological process for the survival of human beings. Having good sleep quality is crucial since it greatly affects various aspects in relation to quality of life[3)]. Chronic exposure to poor sleep quality is related to depression, anxiety, and other health problems[4)]. Quality sleep is necessary for a person's physical health, and physical therapists can help individuals achieve restful sleep through a variety of strategies such as exercise, massage, and other relaxation techniques[5)].

Aromatherapy has emerged in recent years as a complementary and alternative treatment, defined as the application of essential oils or herbal essences extracted from natural plants using various delivery methods (e.g., inhalation, massage, compression, whole body or foot bath, external or internal skin absorption, and ingestion) for medicinal purposes through scents. It is well known that aromatherapy is one of the most popular complementary health methods for improving relaxation and sleep quality[6–8)].

Overall, the use of aromatherapy candles is an easy and popular way to add atmosphere and aroma to a room. Importantly, candles can induce calmness and relaxation. In addition, they can be placed anywhere in the home. Scented candles light up

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the place and fill the room with a beautiful fragrance. Individuals are more likely to use scented candles because they can be used as home decorations and come in a variety of beautiful designs at affordable prices. Additionally, they are organic and very simple to use[9, 10].

Lychee is a delicious tropical and subtropical fruit, with many unique aromatic genetic sources emerging over more than 2,000 years of cultivation[11]. One study reported that nerolidol is the most important aromatic compound in the sweetheart lychee. Importantly, linalool was also discovered to be the most important aromatic compound in the sweetheart lychee[12].

Previous reports have shown that using aromatherapy, especially lavender essential oils, can help relieve stress and improve sleep quality. Linalool is the most common terpene in lavender and has a calming and soothing effect[13–16]. However, the effects of lychee aromatherapy on health-related outcomes have not been studied. Therefore, the purpose of this pilot study is to investigate the effects of lychee soy wax candles on stress and sleep quality in adults and the elderly.

PARTICIPANTS AND METHODS

The study was approved by the University of Phayao Human Ethics Committee (UP-HEC 1.2/092/66), while the Thai Clinical Trials Registry (TCTR20230711004) approved the protocol. All participants provided written informed consent prior to testing.

A total of 30 healthy participants were included in the study. Convenience sampling was used to expedite the collection of data. Participants were randomly allocated into an experimental group (n=15) and a control group (n=15) using the lottery method. The participants were screened according to the inclusion and exclusion criteria. To meet the inclusion criteria, participants must 1) be between 20 to 70 years of age, 2) have no experience of using scented candles or essential oils, 3) receive a score of 2–4 on the pleasantness of the smell on a five-point Likert scale (0=very unsatisfied, 1=unsatisfied, 2=neutral, 3=satisfied, 4=very satisfied), 3) agree to participate in the study, 4) understand the Thai language, and 5) use a smartphone that could be tracked while participating in the study. Individuals were excluded if they had a history of fragrance allergy, sinusitis, respiratory disease, and smell abnormalities.

Perceived stress was assessed using the Suanprung Stress Test-20 (SPST-20), which had an acceptable reliability according to Cronbach's alpha of 0.7. This self-assessment tool contained 20 items, rated on a 5-point Likert scale, with item responses ranging from: "1" (no stress) to "5" (extremely high stress). The total scores were classified into four stress levels: mild (0 to 23), moderate (24 to 41), high (42 to 61), and severe (more than 61). The total scores ranged from 0 to 100, with a higher score indicating more severe stress[17].

Sleep quality was assessed using the Thai-Pittsburgh Sleep Quality Index (Thai-PSQI). The Thai-PSQI is a valid and reliable tool for screening and determining the presence of significant sleep disturbances and is comparable with the original English version. This measure consisted of 19 individual items, forming seven components (subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, use of sleep medication, and daytime dysfunction) to produce one global score. A cut-off value of >5 suggested poor sleep quality[18]. All subjective outcomes were determined at the baseline, two weeks and four weeks after scent inhalation. The assessment researcher was unaware of the group allocation.

The experimental group inhaled the scent from the lychee soy wax candle prior to going to bed for four weeks (20 minutes/session, three days/week). This study was the first study that used aromatherapy in term of scented candles, specifically lychee scent. For this reason, we attempted to adopt the administrative reference for lychee-scented candles from the previous research which had similar outcome parameters. A candle warmer was used to melt the lychee soy wax candle (60 mL) in a private bedroom. The control group was instructed to maintain their current lifestyle and abstain from using any aromatherapy products.

The procedures for making lychee-scented candles and the safety precautions were as follows: Firstly, melt natural soy wax in a pot until it became homogeneous and wait for the temperature to cool down. Secondly, add lychee essential oil and hydrosol then stir until the ingredients were blended. Thirdly, pour the melted candle into the prepared glass and wait for the candle to set. Finally, close the lid 2 days before use. The safety precautions were considered and screened by Inhalation test trying out in 10 volunteers. Hong Huay lychee was chosen to steam distillation for making hydrosol. For lychee essential oil, we used PHATOIL essential oil which was widely used for aromatherapy.

Statistical analysis was performed using the non-parametric method because the normality test was not satisfied. The differences in stress and sleep quality before and after inhalation between the two groups were analyzed using the Mann–Whiney U test, and within-group differences before and after inhalation (two weeks and four weeks after scent inhalation) were analyzed using the Friedman test and Wilcoxon signed-ranks test. The data were analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). The significance level (α) was set at 0.05.

RESULTS

Two participants from each group were excluded from the analysis due to being infected with COVID-19 during data collection. Regarding the protocol-specific analysis, the data on 26 participants (13 people in each group) were analyzed as they performed 100% of the inhalation program. The baseline characteristics of the participants are presented in Table 1.

According to Table 2, sleep quality showed statistically significant differences between the groups after four weeks of scent inhalation ($p<0.05$). For stress, no significant difference was identified between the two groups at any time.

Table 3 presents a statistically significant reduction in stress in the experimental group over time. The results demonstrated a statistically significant increase in stress over time in the control group. A statistically significant deterioration in sleep quality in the experimental group over time is also shown in this table. However, there were no significant differences in the control group.

DISCUSSION

This preliminary study aimed to determine the effects of lychee-scented candle inhalation on stress and sleep quality among adults and the elderly. It was hypothesized that the inhalation of a lychee-scented candle would create a more relaxing atmosphere, reduce stress, and improve sleep quality.

The results indicated a significant difference between the sleep quality scores for the two groups after a four-week inhalation program ($p<0.05$). Notably, sleep quality scores for the experimental group showed a significant decrease over time from the baseline ($p<0.01$). Regarding stress, no significant difference was observed between the two groups over time. However, the stress score for the experimental group decreased significantly over time compared to the baseline ($p<0.01$). In contrast, the control group's stress scores increased significantly over time compared to the baseline ($p<0.01$).

This study was the first study to investigate the effect of lychee aromatherapy on sleep quality and stress levels. Thus, it was difficult to compare results across previous studies. The lychee-scented candle only had a positive effect on sleep quality,

Table 1. Baseline characteristics of the participants (N=26)

Variables	Experimental group (n=13)	Control group (n=13)
Gender: Male/Female	4/9	7/6
Age (years)	40.1 ± 16.6	37.5 ± 16.0
(min–max)	(20–64)	(20–62)
Weight (kg)	56.6 ± 8.7	55.2 ± 8.8
Height (cm)	163.5 ± 4.9	165.8 ± 7.0
Stress: SPST-20 (score)	33.1 ± 7.9	31.2 ± 7.0
Sleep quality: Thai-PQSI (score)	5.4 ± 0.7	4.9 ± 0.7

Mean ± SD, SPST-20: Suanprung Stress Test-20; Thai-PQSI: Thai version of the Pittsburgh Sleep Quality Index; SD: standard deviation.

Table 2. Comparisons of stress scores between two groups and within group before, after 2 weeks, and after 4 weeks of the scent inhalation

Variables	Time	Control group (n=13)	Experiment group (n=13)
Stress: SPST-20 (score)	Baseline assessment	31.2 ± 7.0	33.1 ± 7.9
	After 2 weeks of the scent inhalation	31.6 ± 7.2	32.3 ± 7.7
	After 4 weeks of the scent inhalation	32.8 ± 7.8	29.7 ± 7.2
Sleep quality: Thai-PQSI (score)	Baseline assessment	4.9 ± 0.7	5.4 ± 0.7
	After 2 weeks of the scent inhalation	4.9 ± 0.9	5.2 ± 0.7
	After 4 weeks of the scent inhalation	5.3 ± 1.2	4.2 ± 0.8*

Mean ± SD, *$p<0.05$: comparison with the control group.
SPST-20: Suanprung Stress Test-20; Thai-PQSI: Thai version of the Pittsburgh Sleep Quality Index; SD: standard deviation.

Table 3. Comparisons of stress scores and sleep quality across time within each group

Variables	Control group (n=13)			Experiment group (n=13)		
	Baseline assessment	After 2 weeks of the scent inhalation	After 4 weeks of the scent inhalation	Baseline assessment	After 2 weeks of the scent inhalation	After 4 weeks of the scent inhalation
SPST-20	31.2 ± 7.0	31.6 ± 7.2	32.8 ± 7.8[a, b]	33.1 ± 7.9	32.3 ± 7.7 [b]	29.7 ± 7.2[b, c]
Thai-PQSI	4.9 ± 0.7	4.9 ± 0.9	5.3 ± 1.2	5.38 ± 0.7	5.2 ± 0.7	4.2 ± 0.8[b, c]

[a]$p<0.05$: comparison with the value on after 2 weeks of the scent inhalation.
[b]$p<0.01$: comparison with the value on baseline assessment.
[c]$p<0.01$: comparison with the value on after 2 weeks of the scent inhalation.
SPST-20: Suanprung Stress Test-20; Thai-PQSI: Thai version of the Pittsburgh Sleep Quality Index.

with no adverse events reported, in similarity to the results obtained in previous investigations. Although the current findings denoted the stress levels of the experimental group tended to decrease more than those in the control group, statistical analysis revealed that lychee aromatherapy had no effect on reducing stress. Evidence suggests that terpene, namely linalool, is actually an active chemical component found in lavender and very powerful in reducing stress as well as improving sleep quality[16]. These results are in line with the previous findings in that aromatherapy with lavender oil is one of the nonpharmacological methods used to improve the quality of sleep.

It has been reported that the compound in lavender that relaxes humans is called linalool, a terpene found in lychee. Besides, a previous study reported that the unique aroma of nerolidol can have a calming effect, potentially enhancing mood and promoting relaxation[12]. Based on the results of this present research, the improvement in sleep quality may be attributed to the presence of linalool and nerolidol in lychee.

Linalool and nerolidol contained in lychee may act on the hypothalamus, pituitary, and olfactory nerves. This action can trigger memory, elicit emotional responses, reduce sympathetic nerve activity, increase parasympathetic nerve activity, and lower heart rate and blood pressure. These effects collectively promote relaxation, leading to improved sleep[19].

The research conducted by Genc et al.[14] on 59 older adults residing in a nursing home revealed that lavender aromatherapy administered half an hour before participants in the experimental group slept every day for a month can improve sleep quality by considering the PSQI score. During administration, two drops of lavender oil were dripped onto a small cotton pad and placed on a stand. Similarly, in the quasi-experimental research conducted by Faydali et al.[15] on 30 elderly people residing in a nursing home, it was determined that aromatherapy applied with lavender oil had a positive effect on sleep quality by considering the PSQI score. During the experiment, 0.1 cc of lavender oil was dripped onto the pillows of the nursing home residents every night for a week.

This pilot study has several limitations that should be considered. Firstly, the study design was not double-blinded, which could potentially introduce bias and result in an overestimation of the effect. A crossover study design would be preferable in the future. Secondly, the study sample comprised healthy individuals, so the results may not be generalizable to patients with sleep disorders. To address these issues, it would be necessary to design a study with a more diverse pool of participants. Recruiting research participants with high-stress levels should also be considered in further studies. When interpreting the score of Thai-PSQI based on the cutoff point, the difference in mean value of sleep quality between the two groups at baseline might affect the study's finding since the experimental group seemed to be a lot better in sleep quality compared to the control group. Therefore, further studies should recruit participants who have the score of Thai-PSQI ≤ 5. Thirdly, since linalool and nerolidol were not presented in the lychee used in our study, and different strains of lychee fruit did not contain the same amount of these compounds. In future research, component analysis may be necessary to evaluate bioactive ingredient (compound and amount) in the lychee fruit that was used in the study prior to stream distillation. Fourthly, the difference in room size, characteristic and elements of each participant in the experimental group might affect inhalation exposure and outcome of the experiment. Further studies should consider these points and attempt to control the same suitable environment. Fifthly, some factors such as caffeine, nicotine, exercise, and menstruation might affect subjective outcomes. Drake et al.[20] suggested that caffeine taken 6 hours before bedtime had important disruptive effects on sleep. The study of Tarun et al.[21] showed that high nicotine dependence was significantly associated with high perceived stress. Wunsch et al.[22] indicated that physical activity and exercise may be able to buffer the negative effects of stress on health-related outcomes. Also, a recent systematic review concluded that poor sleep satisfaction and efficiency, sleepiness during waking hours, and shorter sleep duration were associated with menstrual disturbances including premenstrual syndrome, dysmenorrhea, abnormal menstrual cycle, and heavy bleeding during periods[23]. For these reasons, future research can benefit from consideration of these relating points. Finally, this study did not explore the physiological changes underlying the observed improvement in sleep quality. For better understanding, blood pressure, heart rate, and cortisol levels should be explored in future studies to verify the stress outcome.

In conclusion, the inhalation of a lychee-scented candle may be a useful, nonpharmacological method for improving sleep quality among adults and the elderly. However, this study does not provide evidence to support the effectiveness of lychee-scented candle inhalation in reducing stress.

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Conflict of interest

The authors report no conflicts of interest.

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