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Original Article

Physiology Section

Impact of Half an Hour Inhalation of Lemongrass Oil on Audio Visual Reaction Time: A Quasi-experimental Study

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ABSTRACT

Introduction: Lemongrass oil has become a significant focus in aromatherapy research due to its psychomodulatory effects, which are believed to act through the limbic system- a critical region for emotional control and memory. Research indicates that lemongrass oil can effectively lower anxiety, improve mood and enhance cognitive performance. However, the specific mechanisms by which lemongrass oil influences neuronal excitability and synaptic transmission remain unclear.

Aim: To explore Auditory Reaction Time (ART) and Visual Reaction Time (VRT) to gain a better understanding of the neurophysiological effects of lemongrass oil and its potential therapeutic uses following 30 minutes of inhalation of lemongrass oil.

Materials and Methods: This quasi-experimental study was conducted on 30 healthy volunteers after obtaining clearance from the ethics committee and informed consent from the participants. The audio visual reaction times were recorded twice for each subject, before and after the intervention- i.e., 30 minutes of inhalation of lemongrass oil using an aroma lamp. The data were analysed using Statistical Package for the Social Sciences (SPSS) version 20.0, and a paired t-test was applied.

Results: The present study showed a significant decrease in both ART and VRT (p-value=0.001 and 0.02, respectively) after 30 minutes of inhalation of lemongrass oil. The pre-exposure values of ART (1.01±0.46 msec) decreased to 0.79±0.29 msec, while VRT (0.70±0.29 msec) decreased to 0.63±0.26 msec.

Conclusion: The shortened ART and VRT indicate the stimulatory effect of inhaling lemongrass oil on central neurons, especially in the limbic system, through the activation of GABA (gamma-aminobutyric acid) receptors. Hence, this results in increased attention and alertness in the brain.

Keywords: Complementary therapy, Mind body therapy, Phytotherapy, Psychophysiology, Reaction time

INTRODUCTION

Olfaction, though less studied compared to other sensory systems, remains an integral part of human perception. While our sense of smell is less sensitive than that of many non human primates, humans can still detect subtle differences in odour intensity and recognise thousands of distinct scents [1]. Some researchers suggest that difficulties in odour detection may be attributed more to memory retrieval issues than to a limited olfactory capacity [2]. Odour perception begins when airborne molecules enter the nostrils and interact with the olfactory mucosa. These molecules trigger receptor neurons and proteins, setting off an electrical signal that travels to the olfactory bulb and connects with the olfactory cortex [3]. The olfactory system is closely linked to the limbic system, which regulates memory, emotions and behaviour. Due to this connection, it is plausible that different scents could impact cognitive processes and emotional states [4].

Essential oils, commonly used in aromatherapy, have gained significant attention for their potential to influence mood, cognition and various physiological responses. Oils such as lemongrass, peppermint and rosemary have been extensively researched for their effects on brain wave activity, the autonomic nervous system, and emotional wellbeing [5-7]. Among cognitive measures, reaction time-defined as the time interval between the presentation of a stimulus and the initiation of a voluntary response- is an effective marker for evaluating sensory and motor function. Reaction time is a critical measure of cognitive performance, involving both sensory input and motor response [8].

Previous studies have demonstrated the cognitive and emotional benefits of essential oils and found that inhalation of lemongrass oil increases the magnitude of the Contingent Negative Variation (CNV), indicating a stimulating effect [9,10]. However, there is a lack of studies on the effect of lemongrass oil on reaction time. Therefore, the present study was designed to investigate whether short-term inhalation of lemongrass oil can improve audio visual reaction time, potentially offering new insights into its effects on cognitive and neuronal function. This study is part of a larger research project investigating the effects of essential oils on cognitive performance.

MATERIALS AND METHODS

The study was designed as a quasi-experimental investigation conducted in Department of Physiology, Geetanjali Medical College, Udaipur, Rajasthan, India. It commenced after receiving approval from the Human Research Ethics Committee (HREC; GU/HREC/2019/1707) and took place from July 2019 to May 2022. Participants were recruited after obtaining their consent to participate in the study.

Inclusion criteria: Healthy participants aged between 18 and 20 years were included in this study.

Exclusion criteria: Participants with colds, hearing impairments, or visual defects based on their medical history were excluded from the study.

After fulfilling the inclusion criteria, the participants were enrolled in the study.

Sample size: A total of 30 healthy, age-matched participants, aged 18 to 20 years, were included based on a sample size calculation that used a standard deviation of 21, a confidence level of 95%, and a precision of 7.5% [11].

Pre-exposure phase: After the preliminary work-up, the audio visual reaction time was measured in a quiet room using the RTM-608 machine provided by Medicaid, Chandigarh, India. This device features a sensitive quartz clock capable of measuring up to

1/10th of a millisecond with an accuracy of ±1 digit [12]. To ensure accuracy and alleviate any fear or apprehension, each subject was made familiar with the apparatus and procedure before the test. The test itself was conducted with the participant seated comfortably on a chair. Each participant was instructed to use their dominant hand to press the switch on the apparatus upon perceiving the stimulus. Prior to measuring VRT, the participant was familiarised with the flashing of red, green and yellow lights and was instructed to turn off the light as soon as they perceived it. Overall, nine random stimuli were presented to each subject, including three stimuli for each colour of light. To measure ART, the subjects were instructed to focus on the sound signal and immediately turn it off by pressing the corresponding button. The stimuli consisted of three sound signals: a continuous beep at 250 Hz, 500 Hz and 750 Hz. Each of these sounds was randomly presented nine times to the participant to record three reaction time readings for each stimulus [13].

Intervention: After the pretest was completed, an aroma lamp was lit five minutes before the participants entered the room to ensure that the lemongrass aroma was evenly dispersed. A ceramic aroma burner, which has a 40 mL capacity in the chamber on top, was used. The chamber was filled with water, and 10 to 12 drops of lemongrass oil were added. A tea light candle, with a burn time of 45 minutes, was placed under the chamber. Participants were then seated for 30 minutes and asked to continue their tasks without using mobile phones for games, music, or any other activities that could stimulate the sympathetic or parasympathetic systems. After 30 minutes of inhaling the aromatherapy, the participants proceeded to the post-test.

Postexposure phase: After a 30-minute exposure to the aroma, ART and VRTs were measured using the same procedures as those employed during the pre-exposure phase.

STATISTICAL ANALYSIS

The data were analysed using IBM SPSS version 20.0. Parameters such as age and reaction time were assessed for central tendency and presented as mean±SD. Since the study involved pre- and post-exposure measurements of lemongrass oil, a paired t-test was applied, with a significance level set at p-value <0.05.

RESULTS

The participant ratio of males to females was 14:16, with a mean±SD age of 19.34±0.72 years.

The observation indicated that a 30-minute exposure to inhalational lemongrass oil using an aroma lamp significantly decreases visual and ARTs (p-value=0.02 and p-value=0.001, respectively) compared to the pre-exposure levels [Table/Fig-1].

Exposure	Mean VRT±SD (msec)	Mean ART±SD (msec)
Pre-exposure	0.70±0.29	1.01±0.46
Postexposure	0.63±0.26	0.79±0.29
p-value	0.02*	0.001**

[Table/Fig-1]: Difference of mean VRT and ART (msec) during pre-exposure and postexposure of 30 minutes inhalational of lemongrass oil.
*Significant with p <0.05; **Highly Significant with p <0.01

DISCUSSION

The results of this study indicate that a 30-minute exposure to lemongrass oil aromatherapy significantly decreases both ART and VRT s in healthy participants. Specifically, the mean VRT decreased from 0.70 seconds before exposure to 0.63 seconds after exposure, with a statistically significant p-value of 0.02. Similarly, the mean ART changed from 1.01 seconds to 0.79 seconds, also showing significance with a p-value of 0.001.

Lemongrass oil contains bioactive compounds such as citral, geraniol and limonene, as described by Torres AJ et al., showed lemongrass exert stimulating effects on the Central Nervous System (CNS) [14]. Citral, a major component, plays a critical role in this stimulation, enhancing cognitive performance and promoting heightened alertness. This is supported by Tognolini M et al., who identified geranial and neral as the primary constituents of citral, comprising 41.28% and 32.28% of the oil, respectively [15].

The stimulatory effects of lemongrass oil on cognitive function can be understood through its impact on key brain areas, including the hypothalamus and limbic system, which regulate arousal, attention and mood. Previous studies, such as those conducted by Yamaguchi N and Kikuchi T et al., demonstrated that exposure to lemon-based aromas increased heart rate, suggesting heightened arousal and cognitive stimulation [16,17]. This was consistent with the results of the present study, where decreased reaction times imply enhanced alertness and faster cognitive processing in participants.

The present findings are further supported by Smith AP, who found that exposure to lemon aromas made participants feel more awake, alert and energised [18]. This effect on mood and cognitive function is likely due to the synergistic interaction of lemongrass oil's various compounds, such as citral, limonene and myrcene, which stimulate the CNS and modulate neuronal excitability [18,19]. Moreover, lemongrass oil has been linked to GABAergic modulation, as seen in studies by Manley KJ and Negrelle RRB and Gomes EC, who observed that lemongrass oil interacts with the GABAA receptor-benzodiazepine complex, affecting both arousal and anxiety regulation [20,21].

Conversely, some studies offer differing perspectives on the effects of lemongrass. For example, research conducted by Nascimento JRO et al., found no significant influence of lemongrass oil on cognitive performance, indicating that individual reactions to essential oils may vary considerably due to factors such as dosage and personal sensitivities [22]. Additionally, a review by Braden MN et al., suggested that while certain essential oils, such as peppermint and rosemary oil, may enhance cognitive function, others, like sandalwood, bergamot and tea tree oil, may have little to no impact. This highlights the need for more comprehensive research to better understand the specific conditions and contexts under which these oils can effectively influence cognitive performance [23].

Limitation(s)

The study was carefully designed to explore the effects of aromatic lemongrass oil, but it encountered some limitations. The sample size was relatively small, which may limit the generalisability of the findings. A larger sample size could potentially provide more robust results and enhance the statistical power of the study. Additionally, the duration of exposure to aromatic lemongrass oil was restricted to 30 minutes; extending this exposure might yield more significant outcomes. Furthermore, the absence of a control group restricts the ability to draw definitive conclusions regarding the effectiveness of lemongrass oil, as it prevents comparisons with a baseline or untreated group. Further research could explore its broader therapeutic applications, particularly in cognitive enhancement and stress management.

CONCLUSION(S)

The inhalation of lemongrass oil has been shown to shorten ART and VRT, indicating its stimulatory impact on the CNS, particularly within the limbic system, by activating GABA receptors. This, in turn, enhances attention and alertness in the brain. The findings of this study align with earlier research that also highlights the positive effects of lemongrass oil on cognitive function. The observed reduction in ART and VRT underscores the potential of lemongrass oil, especially its citral component, to boost cognitive performance by influencing the neural pathways responsible for attention and alertness.

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