



# Effects of *Rosmarinus officinalis* L. on memory performance, anxiety, depression, and sleep quality in university students: A randomized clinical trial



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## ABSTRACT

**Objective:** To evaluate the effects of oral rosemary on memory performance, anxiety, depression, and sleep quality in university students.

**Methods:** In this double-blinded randomized controlled trial, the 68 participating students randomly received 500 mg rosemary and placebo twice daily for one month. Prospective and retrospective memory performance, depression, anxiety and sleep quality of the students were measured using Prospective and Retrospective Memory Questionnaire, Hospital Anxiety and Depression Scale, and Pittsburgh Sleep Quality Inventory at baseline and after one month.

**Results:** The scores of all the scales and subscales except the sleep latency and sleep duration components of Pittsburgh Sleep Quality Inventory were significantly decreased in the rosemary group in comparison with the control group after one month.

**Conclusions:** Rosemary as a traditional herb could be used to boost prospective and retrospective memory, reduce anxiety and depression, and improve sleep quality in university students.

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## 1. Introduction

*Rosmarinus officinalis* L. (rosemary) is an aromatic evergreen shrub which belongs to Lamiaceae family. It is an ancient herb originated from the Mediterranean and Asia and is cultivated worldwide. This common household plant is widely used because of its nutritional, medicinal and aromatic properties [1,2].

The biological activities of rosemary are mainly related to the volatile constituents such as  $\alpha$ -pinene, 1,8-cineole and camphor, and the phenolic compounds such as carnosol, carnosic acid and rosmarinic acid. Some biological activities of rosemary include antioxidant, antibacterial, antifungal, anticancer, anti-inflammatory, antidiabetic, antithrombotic, antinociceptive, anti-Alzheimer, antidepressant and anti-anxiety effects [1,3]. Rosemary is also approved as a food additive in Europe [4].

Different studies have shown that rosemary has beneficial effects on memory, anxiety, depression and insomnia [1,3]. Memory improvement with rosemary may be explained by its inhibitory effect on acetylcholinesterase in the brain [3]. Additionally, anti-anxiety, antidepressant and sedative properties of rosemary are associated with its effect on gamma-aminobutyric acid (GABA) receptors [5]. Furthermore, the antioxidant property of rosemary may also be responsible for its effects on anxiety and cognitive function [3].

Anxiety, depression, and sleep disorders are common among university students [6–8] and also have significant effects on memory impairment in this population [8,9]. Currently, the use of stimulant drugs by university students to improve their memory performance and attention is increasing [10,11]. This unapproved and non-therapeutic use can cause different and serious adverse effects. Therefore, identifying a cognitive enhancing drug that can be used without adverse effects in healthy people has captured the interest of researchers in neuroscience [11].

Based on the above, rosemary could be used as memory enhancer by university students, and it is preferred to stimulant

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drugs because of its safety [1]. In addition, rosemary may improve anxiety, depression and sleep quality. Yet, studies related to the effects of oral rosemary on the brain and nervous system are limited [12,13] and more research in this regard is required. This study was designed to evaluate the effects of oral rosemary on memory performance, anxiety, depression, and sleep quality in university students.

## 2. Materials and methods

### 2.1. Ethical considerations

The present study was approved by the ethical committee of Kerman University of Medical Sciences and registered in the Iranian Registry of Clinical Trial with identity number IRCT201703136026N6. All the participants signed an informed consent form.

### 2.2. Study design and participants

This double-blinded randomized controlled trial was conducted in Kerman University of Medical Sciences, Kerman, Iran, from April to June 2017. The participants and a researcher assessing the outcomes were blinded. Students in the age range of 20–25 years were included in this trial. The exclusion criteria were having any medical diseases or psychiatric disorders, using any medicines even complementary and alternative medicines, being pregnant and lactating. A total of 79 students agreed to participate in this study, but just 68 students completed this trial. Fig. 1 shows the consort flow diagram of this trial.

### 2.3. Interventions

The participating students were divided into two groups (rosemary and control) using block randomization (34 students in each group). Dried powdered aerial parts of rosemary (in rosemary group) and starch as placebo (in control group) were administered as one 500 mg capsule twice daily for one month. The rosemary and placebo capsules had the same shape, color and outer packaging. It should be noted that it would be possible for the participants who were given rosemary capsules to identify it because of its distinctive flavor and smell.

Fresh aerial parts of rosemary were collected from Kerman, Iran and identified by Prof. Mitra Mehrabani from Kerman University of Medical Sciences. The total phenolic content of rosemary aerial parts was  $20.1 \pm 0.12$  mg gallic acid/g dried weight measured by the Folin-ciocalteu method [14]. Also, the compositions of rosemary essential oil that had grown in Kerman had been previously reported by Jamshidi et al. [15].

### 2.4. Measurements

Prospective and retrospective memory performance, depression, anxiety, sleep quality, sleep latency, and sleep duration of the students were measured using self-reported questionnaires at baseline and after one month.

The validated Persian version of Prospective and Retrospective Memory Questionnaire (PRMQ) was used to assess prospective and retrospective memory problems in everyday life [16]. This questionnaire has 16 items scored from 5 (very often) to 1 (never) for each item. The lower scores mean having less memory problems. The PRMQ has two subscales: Prospective Memory with 8 items and Retrospective Memory with 8 items [17].

Hospital Anxiety and Depression Scale (HADS), a validated Persian version [18], was used to measure anxiety and depression

in the students. The HADS is a 14-item questionnaire with a scale from 0 to 3 for each item. This questionnaire consists of two subscales: anxiety (7 items) and depression (7 items) with cut-off points for severity (scores: 0–7 normal; 8–10 mild; 11–15 moderate; 16–21 severe) [19].

The validated Persian version [20] of Pittsburgh Sleep Quality Inventory (PSQI) was used to evaluate sleep quality. This questionnaire contains 7 components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction. Among the stated components, sleep latency and sleep duration were the two examined in the current study. Higher scores indicate worse sleep quality. Individuals with the PSQI scores greater than 5 were classified as poor sleepers [21].

### 2.5. Statistical analysis

The Statistical Package of Social Science (SPSS) version 20 was used for all the analyses. The data was normally distributed based on Kolmogorov–Smirnov test. Two-tailed *t*-test and chi-square (or Fisher's exact test) were applied to evaluate the differences in demographic data and grades of anxiety, depression and sleep quality between the two groups. Mixed model analysis of variance was used to compare changes over time in scores for each scale between rosemary and control groups. Paired sample *t*-test was used to compare the changes over time in scores of the scales in each group. *P* values less than 0.05 were considered statistically significant.

## 3. Results

The mean  $\pm$  SD age of 68 participants was  $22.9 \pm 1.7$  years. Among the participating students, 30 (44.12%) and 38 (55.88%) were male and female, respectively. Demographics of the students in each group are presented in Table 1. The demographic data were not significantly different between rosemary and control groups.

Table 2 shows classification of the students' anxiety, depression and sleep quality status in the two groups at baseline and after one month. There was not any significant difference between the two groups regarding the mentioned status at baseline. Also, only the students' anxiety status was significantly different between the two groups after one month.

The analyses revealed that the main effect of time (within-subjects factor) was statistically significant for all the scales and subscales except the sleep duration component of PSQI. The effect of the interaction between time and group was also statistically significant for all the scales and subscales except the sleep latency and sleep duration components of PSQI. But the main effect of group (between-subject factor) did not reach statistical significance for all the scales and subscales. Changes in the scores for each scale in rosemary and control groups at baseline and after one month are shown in Table 3.

The mean scores of all the scales and subscales except sleep duration were significantly reduced in rosemary group after one month, but were not significantly different for all the scales and subscales in control group after one month (Table 3).

During the current study, some side effects of rosemary were reported by the participants including diuretic effect (3), skin improvements (3), increased libido (2) and appetite (1).

## 4. Discussion

The results of the current study revealed that rosemary had significant effects on enhancing memory performance, reducing anxiety and depression, and improving sleep quality in university students. Few studies have previously investigated the effects of

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